



# **Dialytic Support for AKI patients**

By

**Dr. Ahmed Mohammed Abd El Wahab**

Lecturer of Internal Medicine(Nephrology)

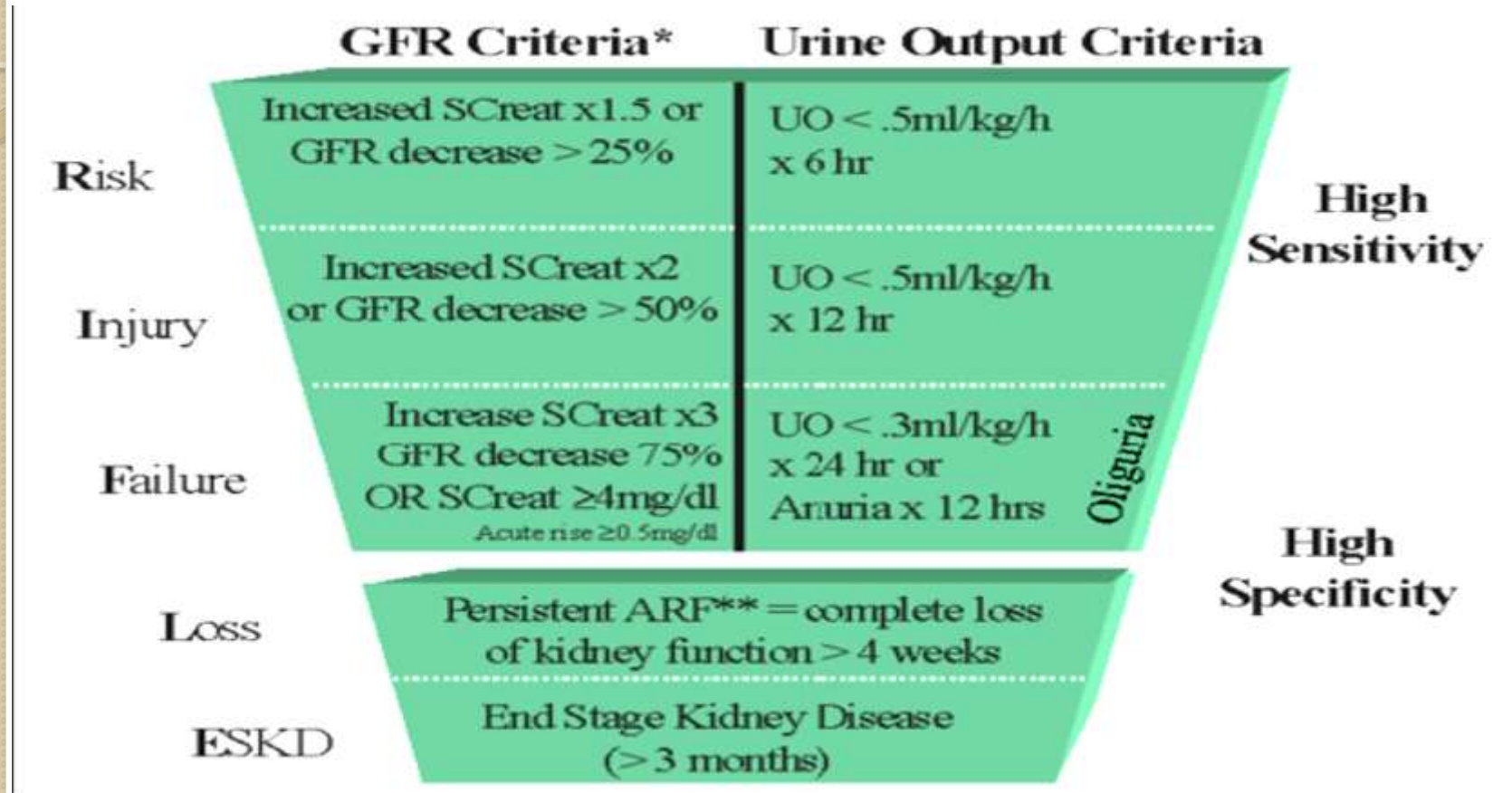
Director of Critical Care and Convalescence Hospital

Mansoura Faculty of medicine



# Classifications & Magnitude

# RIFLE Strata



*The 2<sup>nd</sup> International Consensus Conference of the Acute  
Dialysis Quality Initiative (ADQI) Group*

# Acute Kidney Injury Network (AKIN) and I

## AKIN Staging

### Serum Creatinine

### Urine Output (Common to Both)

Stage 1: Increase of  $\geq 0.3$  mg/dl ( $\geq 26.5$   $\mu\text{mol/l}$ ) or increase to  $\geq 150\%$  to  $200\%$  (1.5-fold to twofold) from baseline

$< 0.5$  ml/kg/h for  $> 6$  h

Stage 2: Increased to  $> 200\%$  to  $300\%$  (more than twofold to threefold) from baseline

$< 0.5$  ml/kg/h for  $> 12$  h

Stage 3: Increased to  $> 300\%$  (more than threefold) from baseline, or  $\geq 4.0$  mg/dl ( $\geq 354$   $\mu\text{mol/l}$ ) with an acute increase of at least  $0.5$  mg/dl ( $44$   $\mu\text{mol/l}$ ) or on RRT

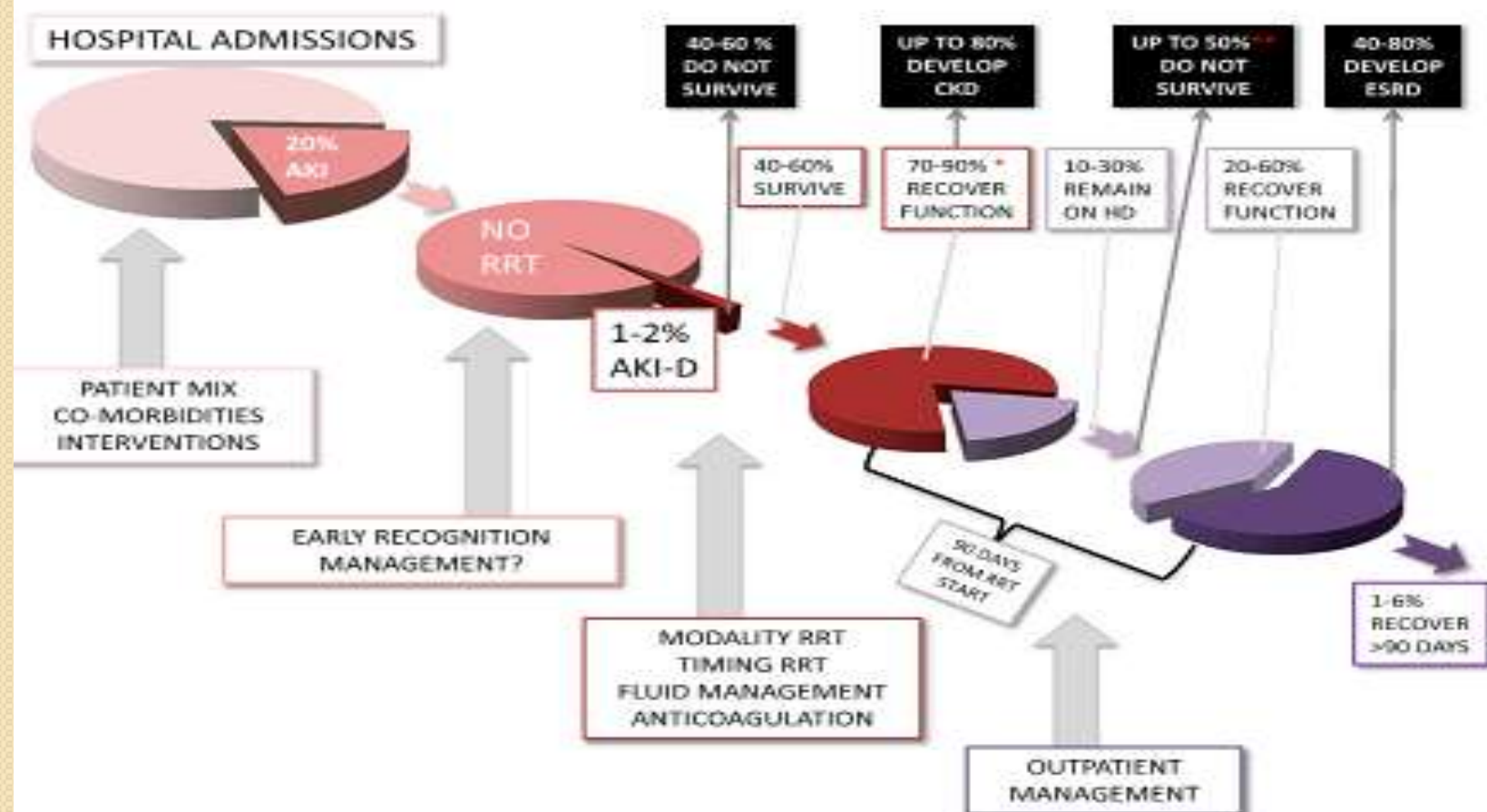
$< 0.3$  ml/kg/h for 24 h  
or anuria for 12 h



## Kidney Disease: Improving Global Outcomes (KDIGO) Composite Staging of AKI

Stage	Serum Creatinine	Urine Output
1	1.5-1.9x baseline OR ≥0.3 mg/dl (≥26 μmol/l) increase	<0.5 ml/kg/h for 6-12 h
2	2.0-2.9x baseline	<0.5 ml/kg/h for ≥12 h
3	3.0x baseline OR Increase in serum creatinine to ≥4.0 mg/dl (≥352 μmol/l) OR Initiation of renal replacement therapy OR, in patients younger than 18 years, decrease in eGFR to <35 ml/min/1.73 m <sup>2</sup>	<0.3 ml/kg/h for ≥24 h OR Anuria for ≥12 h

Jorge Cerdá,\* Kathleen D. Liu,\* Dinna N. Cruz,\* Bertrand L. Jaber,<sup>§</sup> Jay L. Kayner,<sup>¶</sup> Michael Heung,<sup>†</sup> Mark D. Okusa,\*\* and Sarah Faubel,\*\* for the AKI Advisory Group of the American Society of Nephrology



# Where are we - too many questions?

- What do we aim for?
- When should we start it?
- *What therapy should we use?*
- *Which vascular access?*
- How much therapy is enough?
- *When do we stop/switch?*

# The Ideal Renal Replacement Therapy

- Allows control of intra/extravascular volume
- Corrects acid-base disturbances
- Corrects uraemia & effectively clears “toxins”
- Promotes renal recovery
- Improves survival
- Is free of complications
- Clears drugs effectively (?)



Kellum JA, Ronco C, Vincent J-L (eds): Controversies in Acute Kidney Injury. Contrib Nephrol. Basel, Karger, 2011, vol 174, pp 232–241

# Renal Replacement Therapy: When to Start

**Table 2** Summary of absolute or 'rescue therapy' indications for initiation of renal replacement therapy in critically ill patients [10]

Category	Characteristics
Metabolic	
Azotemia	serum urea $\geq 36$ mmol/l (100 mg/dl)
Uremic complications	encephalopathy, pericarditis, bleeding
Hyperkalemia	K <sup>+</sup> $\geq 6$ mmol/l and/or ECG abnormalities refractory to removal by medical measures
Hypermagnesemia	$\geq 4$ mmol/l and/or anuria/absent deep tendon reflexes
Acidosis	serum pH $\leq 7.15$
Oligoanuria	urine output $< 200$ ml/12 h or anuria
Fluid overload	diuretic-resistant organ edema (i.e. pulmonary edema) in the presence of AKI

## RENAL REPLACEMENT THERAPY IN ACUTE KIDNEY INJURY: WHEN, HOW AND HOW MUCH?

### When Should Renal Replacement Therapy be Initiated for Acute Kidney Injury?

**TABLE 2. Factors influencing the decision to start RRT**

---

Patient safety

---

Unnecessary procedure

Possibility of patient recovering renal function

Risk associated with RRT procedure

Complications associated with catheter placement

Hypotension and cardiac events during procedure

Fear of prolonging renal injury after initiation of RRT

---

Factors affecting implementation

---

Logistics

Vascular access availability

Availability of equipment and personnel

Time of decision to initiation (Sundays, late night)

Treating physician decision

## TRANSITION TO DIALYSIS: CONTROVERSIES IN ITS TIMING AND MODALITY

### Timing of Dialysis Initiation in Acute Kidney Injury and Acute-On-Chronic Renal Failure

**TABLE 2. Parameters different studies used to compare timing of renal replacement therapy initiation**

---

Solute level: BUN, sCr (30–32)

Urine output (39–41)

Interval between ICU/hospital admission and RRT initiation (33)

Days between biochemical diagnosis of AKI and RRT initiation (37)

Severity of AKI: AKIN/RIFLE classification (34,36)

Prognostic scores (20,49)

Number of organ failures (63,64)



# When to initiate? Early vs Late

## Serum Creatinine as a trigger for RRT

Study	Time period	RRT mode	Patient population	Parameters at the time of RRT		Outcome (early RRT versus late RRT)
				Early RRT	Late RRT	
Shiao <i>et al.</i> [11]; retrospective study	2002–05	CVVH; IHD	98 patients post-abdominal surgery	AKI as per RIFLE classification; no AKI or RIFLE Risk	AKI as per RIFLE classification; RILFE Injury or Failure	Hospital mortality, 43 versus 75%, P = 0.002
Chou <i>et al.</i> [22]; retrospective study	2002–09	CVVH; SLED-f; SLED; IHD	370 patients with AKI and sepsis in surgical ICU	RIFLE-0 or RIFLE-Risk	RIFLE-Injury or RIFLE-Failure	Hospital mortality, 70.8 versus 69.7%, P > 0.05
Bagshaw <i>et al.</i> [8]; prospective study	2000–01	CRRT; IHD	1238 mixed ICU patients	Serum creatinine $\leq 309 \mu\text{mol/L}$ ; serum urea $\leq 24.2 \text{ mmol/L}$	Serum creatinine $> 309 \mu\text{mol/L}$ ; serum urea $> 24.2 \text{ mmol/L}$	Hospital mortality, 71 versus 53.4%, P = 0.48
Ostermann <i>et al.</i> [13]; retrospective study	1989–99	CRRT; IHD	1847 mixed ICU patients	Serum creatinine $\leq 309 \mu\text{mol/L}$ ; serum pH $< 7.2$	Serum creatinine $> 309 \mu\text{mol/L}$ ; serum pH $\geq 7.2$	ICU mortality, 59 versus 48%, P < 0.0001; 74 versus 48%, P < 0.0001

# When to initiate? Early vs Late

## Serum Urea as a trigger for RRT

Study	Time period	RRT mode	Patient population	Parameters at the time of RRT		Outcome (early RRT versus late RRT)
				Early RRT	Late RRT	
Wu <i>et al.</i> [17]; retrospective study	2002–05	CRRT; IHD	80 patients with AKI and acute liver failure post-surgery	Serum urea <28.6 mmol/L	Serum urea >28.6 mmol/L	ICU mortality, 57 versus 85%, P = 0.02
Gettings <i>et al.</i> [10]; retrospective study	1989–97	CRRT	100 trauma patients	Serum urea <21.4 mmol/L	Serum urea ≥21.4 mmol/L	Hospital mortality, 61 versus 80%, P = 0.041
Carl <i>et al.</i> [20]; retrospective study	2000–04	CRRT	147 patients with AKI and sepsis	Serum urea <35.7 mmol/L	Urea >35.7 mmol/L	28-day mortality, 52.3 versus 68%, P < 0.05
Bagshaw <i>et al.</i> [8]; prospective study	2000–01	CRRT; IHD	1238 mixed ICU patients	Serum creatinine ≤309 μmol/L; serum urea <24.2 mmol/L	Serum creatinine >309 μmol/L; serum urea >24.2 mmol/L	Hospital mortality, 71 versus 53.4%, P < 0.00001; P = 0.48



# When to initiate? Early vs Late

## UOP as a trigger for RRT

Study	Time period	RRT mode	Patient population	Parameters at the time of RRT		Outcome (early RRT versus late RRT)
				Early RRT	Late RRT	
Elahi <i>et al.</i> [12]; retrospective study	2002	CRRT	64 patients post-cardiac surgery	Urine output <100 mL in 8 h	Serum urea $\geq$ 30 mmol/L or serum creatinine $\geq$ 250 $\mu$ mol/L or $K^+$ >6 mmol/L	Hospital mortality, 22 versus 43%, $P < 0.05$
Demirkilic <i>et al.</i> [16]; retrospective study	1992–2001	CRRT	61 patients with AKI post-cardiac surgery	Urine output <100 mL within 8 h post-surgery	Serum creatinine >440 $\mu$ mol/L or $K^+$ >5.5 mmol/L	ICU mortality, 18 versus 48%, $P = 0.014$ ; hospital mortality, 23.5 versus 56%, $P = 0.016$
Iyem <i>et al.</i> [19]; retrospective study	2004–07	CVVH	185 patients with AKI post-cardiac surgery	Urine output $\leq$ 0.5 mL/kg/h and a 50% increase in preoperative urea and creatinine	48 h after urine output $\leq$ 0.5 mL/kg/h and 50% increase in urea and creatinine	Hospital mortality, 5.2 versus 6.6%, $P > 0.05$
Manche <i>et al.</i> [18]; retrospective study	1995–2006	IHD	71 patients with AKI post-cardiac surgery	Urine output <0.5 mL/kg despite fluid challenge and single dose of diuretic	AKI which failed to respond to all supportive medical measures	ICU mortality, 25 versus 87%, $P = 0.00001$
Ji <i>et al.</i> [21]; retrospective study	Before 2010	CVVHD	58 patients with AKI post-cardiac surgery	Urine output <0.5 mL/kg/h for <12 h	Urine output <0.5 mL/kg/h for >12 h	Hospital mortality, 8.8 versus 37.5%, $P = 0.02$

# *The* NEW ENGLAND JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

OCTOBER 22, 2009

VOL. 361 NO. 17

## Intensity of Continuous Renal-Replacement Therapy in Critically Ill Patients

The RENAL Replacement Therapy Study Investigators\*

- **To Consider RRT:**

- Oliguria: urine output <100 ml in 6h
- Potassium >6.5 mmol/L
- pH <7.2
- BUN >70 mg/dl
- Creatinine >3.5 mg/dl
- Clinically significant organ edema

# *The* NEW ENGLAND JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

JULY 3, 2008

VOL. 359 NO. 1

## Intensity of Renal Support in Critically Ill Patients with Acute Kidney Injury

The VA/NIH Acute Renal Failure Trial Network\*

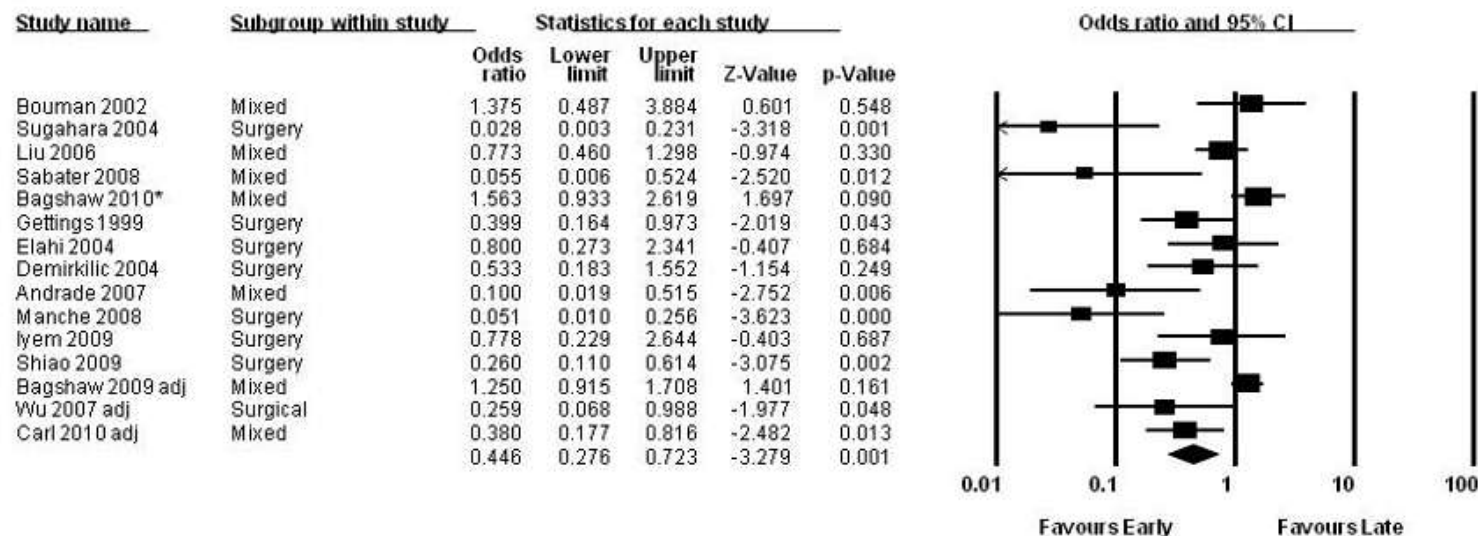
- **To Consider RRT:**
  - Urea  $\geq 21$  mmol/L
  - Volume overload
  - Persistent hyperkalemia ( $K^+ > 6.2$  mEq/L or ECG changes)
  - Severe metabolic acidosis ( $pH < 7.20$ )
  - Uremic signs or symptoms

RESEARCH

Open Access

# A comparison of early versus late initiation of renal replacement therapy in critically ill patients with acute kidney injury: a systematic review and meta-analysis

## Meta Analysis: All 15 studies



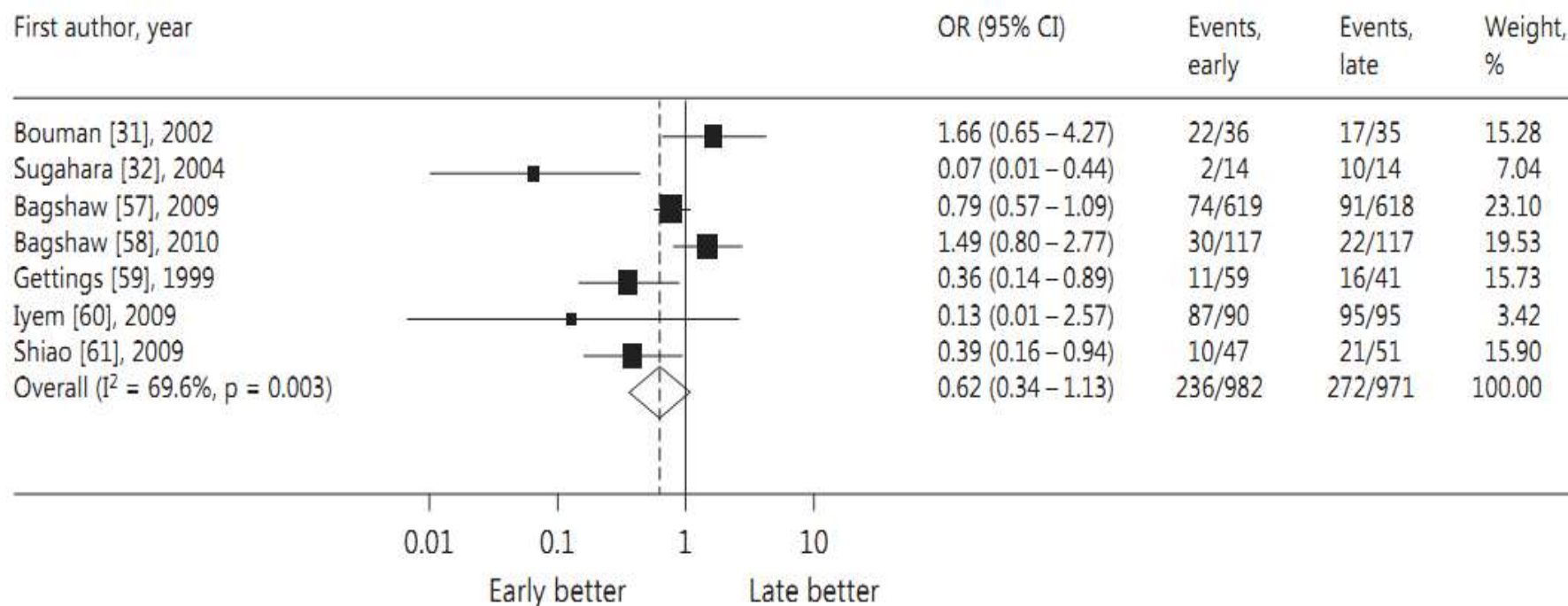
### Meta Analysis

**Figure 2** Forest plot of all 15 studies (Random Effects Model, OR, 95% CI).



# Effects of Renal Replacement Therapy on Renal Recovery after Acute Kidney Injury

Antoine G. Schneider Sean M. Bagshaw



**Figure 1** Pooled analysis of clinical studies evaluating the association between timing of RRT initiation and recovery of kidney function (from Karvellas et al. [30]).



**STUDY PROTOCOL**

**Open Access**

Impact on mortality of the timing of renal replacement therapy in patients with severe acute kidney injury in septic shock: the IDEAL-ICU study (initiation of dialysis early versus delayed in the intensive care unit): study protocol for a randomized controlled trial

Smith et al. *Trials* 2013, **14**:320  
<http://www.trialsjournal.com/content/14/1/320>

**STUDY PROTOCOL**

**Open Access**

Standard versus accelerated initiation of renal replacement therapy in acute kidney injury (STARRT-AKI): study protocol for a randomized controlled trial

### **KDOQI US Commentary on the 2012 KDIGO Clinical Practice Guideline for Acute Kidney Injury**

*Paul M. Palevsky, MD,<sup>1,2</sup> Kathleen D. Liu, MD, PhD,<sup>3</sup> Patrick D. Brophy, MD,<sup>4</sup>  
Lakhmir S. Chawla, MD,<sup>5</sup> Chirag R. Parikh, MD, PhD,<sup>6,7</sup> Charuhas V. Thakar, MD,<sup>8,9</sup>  
Ashita J. Tolwani, MD,<sup>10</sup> Sushrut S. Waikar, MD,<sup>11</sup> and Steven D. Weisbord, MD<sup>1,2</sup>*

- 5.1.1: Initiate RRT emergently when life-threatening changes in fluid, electrolyte, and acid-base balance exist. (*Not Graded*)
- 5.1.2: Consider the broader clinical context, the presence of conditions that can be modified with RRT, and trends of laboratory tests—rather than single BUN and creatinine thresholds alone—when making the decision to start RRT. (*Not Graded*)



## AKI Stage

High Risk

1

2

3

Discontinue all nephrotoxic agents when possible

Ensure volume status and perfusion pressure

Consider functional hemodynamic monitoring

Monitoring Serum creatinine and urine output

Avoid hyperglycemia

Consider alternatives to radiocontrast procedures

Consider invasive diagnostic workup

Consider invasive diagnostic workup

Check for changes in drug dosing

Consider Renal Replacement Therapy

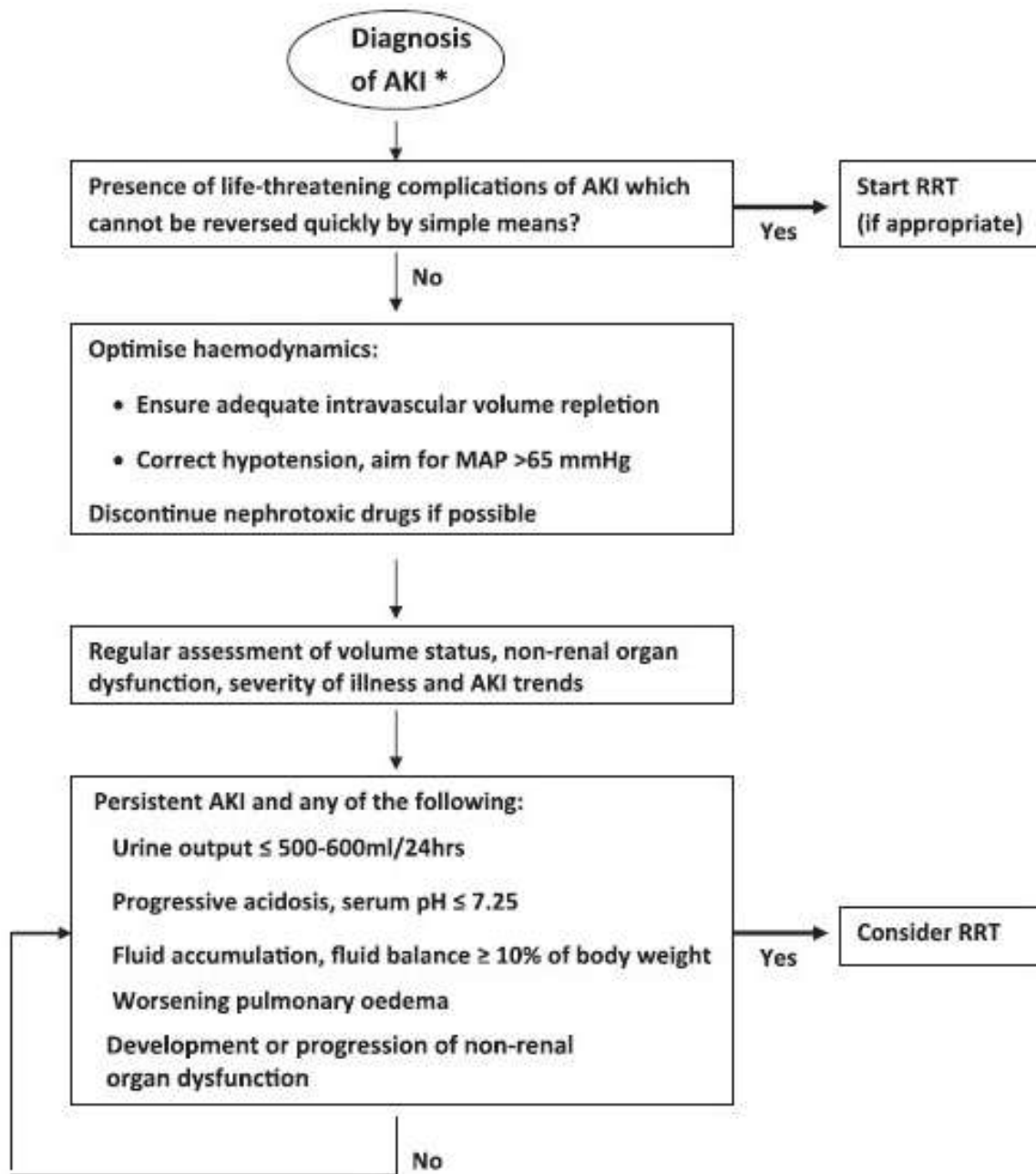
Consider ICU admission

Avoid subclavian catheters if possible

**Table 2 | Staging of AKI**

Stage	Serum creatinine	Urine output
1	1.5–1.9 times baseline OR ≥0.3 mg/dl (≥26.5 μmol/l) increase	<0.5 ml/kg/h for 6–12 hours
2	2.0–2.9 times baseline	<0.5 ml/kg/h for ≥12 hours
3	3.0 times baseline OR Increase in serum creatinine to ≥4.0 mg/dl (≥353.6 μmol/l) OR Initiation of renal replacement therapy OR, In patients <18 years, decrease in eGFR to <35 ml/min per 1.73 m <sup>2</sup>	<0.3 ml/kg/h for ≥24 hours OR Anuria for ≥12 hours





**A proposed  
algorithm for  
initiation RRT in  
adult critically ill  
patients**



Whatever the criteria used to define ‘early’ versus  
‘late’ RRT,

It is apparent that what may be ‘early’ for one patient  
could be ‘late’ for another patient depending on the  
patient’s comorbidity and clinical course





**PACT**  
PATIENT-CENTRED ACUTE  
CARE TRAINING

AN ESICM MULTIDISCIPLINARY DISTANCE LEARNING PROGRAMME  
FOR INTENSIVE CARE TRAINING



# Acute Kidney Injury Part II: renal replacement therapy

## Organ specific problems

2013

Module Authors (update 2013)

Michael Joannidis

Medical Intensive Care Unit, Department of  
General Internal Medicine, Medical University  
Innsbruck, Austria

Lui Forni

Worthing Hospital, Brighton and Sussex Medical  
School, Western Sussex Hospitals NHS Trust, UK



In the critically ill patient with multiple organ failure, the threshold for RRT is much lower, and in such cases one is guided by the clinical picture rather than any classical trigger for commencing therapy.

Starvation or limitation of protein intake should not be used to delay the need for RRT. It is better to provide appropriate nutritional intake and intervene with RRT early.



**Which Modality?**

# Major Renal Replacement Techniques

Intermittent



**IHD**

Intermittent  
haemodialysis

**IUF**

Isolated  
Ultrafiltration

Hybrid



**SLEDD**

Sustained (or slow)  
low efficiency daily  
dialysis

**SLEDD-F**

Sustained (or slow)  
low efficiency daily  
dialysis with filtration

Continuous



**CVVH**

Continuous veno-venous  
haemofiltration

**CVVHD**

Continuous veno-venous  
haemodialysis

**CVVHDF**

Continuous veno-venous  
haemodiafiltration

**SCUF**

Slow continuous  
ultrafiltration

# Intermittent Therapies - PRO

(Relatively) Inexpensive

Flexible timing allows for mobility/transport

Rapid correction of fluid overload

Rapid removal of dialyzable drugs

Rapid correction of acidosis & electrolyte abnormality

Minimises anticoagulant exposure

# Intermittent Therapies - CON

Hypotension 30-60%

Cerebral  
oedema



Limited therapy  
duration

Renal injury &  
ischaemia

Gut/coronary  
ischaemia



# Continuous Therapies - PRO

**Haemodynamic stability => ?? better renal recovery**

**Stable and predictable volume control**

**Stable and predictable control of chemistry**

**Stable intracranial pressure**

**Disease modification by cytokine removal (CVVH)?**

# Continuous Therapies - CON

**Anticoagulation requirements**

**Higher potential for filter clotting**

**Expense – fluids etc.**

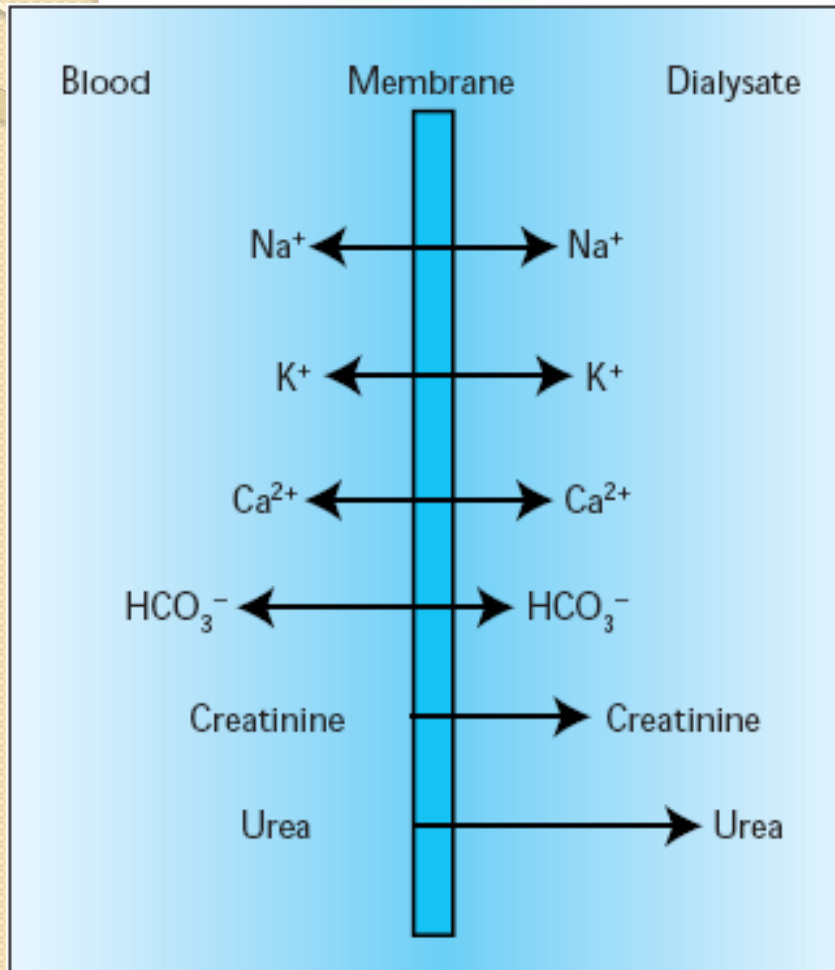
**Immobility & Transport issues**



**Increased bleeding risk**

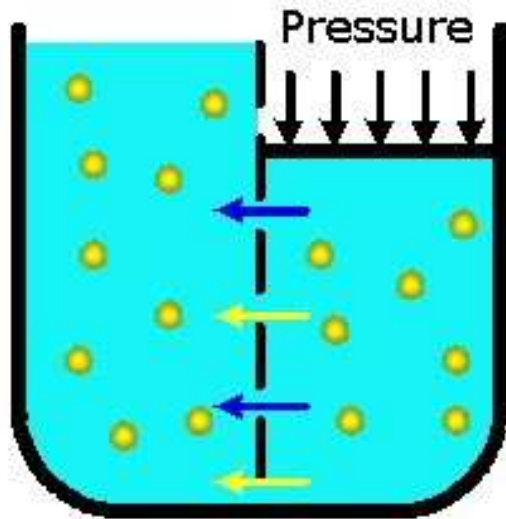
**High heparin exposure**

# Solute Clearance - Diffusion



- Small ( $< 500\text{d}$ ) molecules cleared efficiently
- Concentration gradient critical
- Gradient achieved by countercurrent flow
- Principal clearance mode of dialysis techniques

# Solute Clearance – Ultrafiltration & Convection (Haemofiltration)



## Ultrafiltration

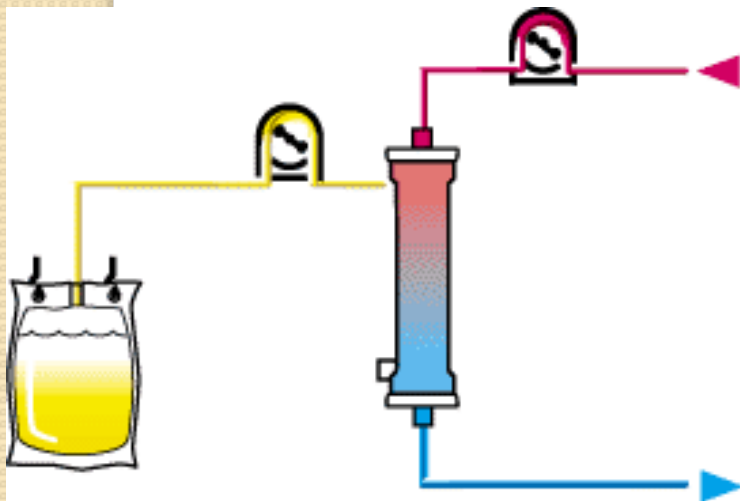
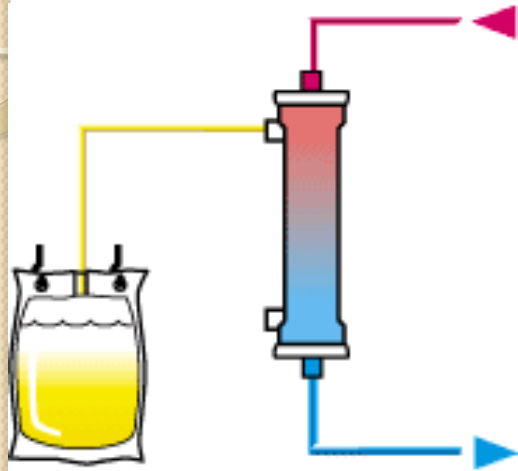
(Solution moves by pressure gradient)

- Water movement “drags” solute across membrane
- At high UF rates ( $> 1\text{ L/hour}$ ) enough solute is dragged to produce significant clearance
- Convective clearance dehydrates the blood passing through the filter
- If filtration fraction  $> 30\%$  there is high risk of filter clotting\*
- Also clears larger molecular weight substances (e.g. B12, TNF, inulin)

\* In post-dilution haemofiltration

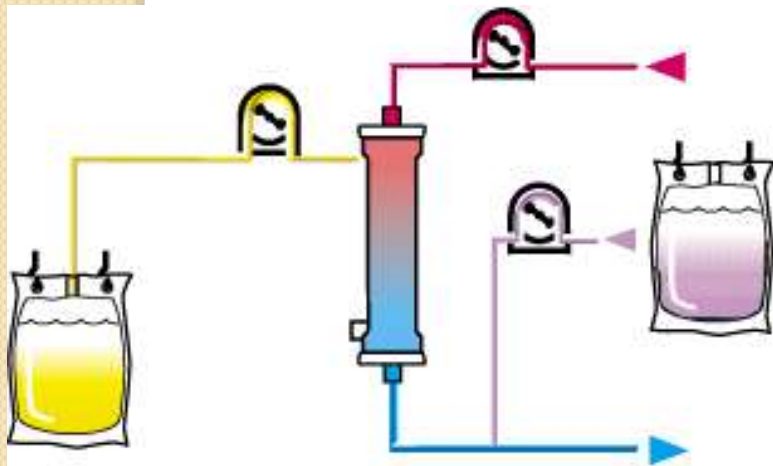
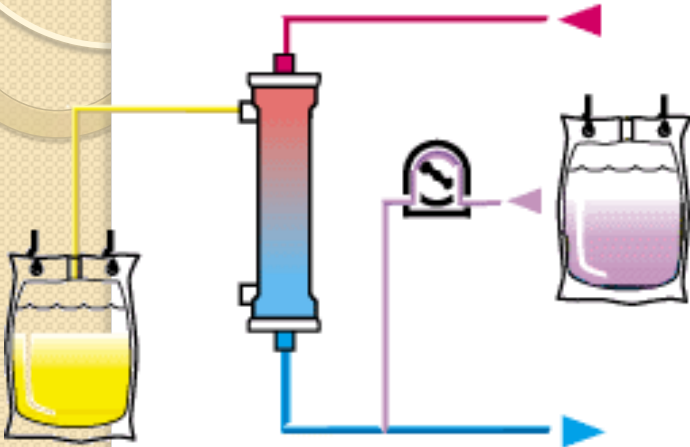


# SCUF



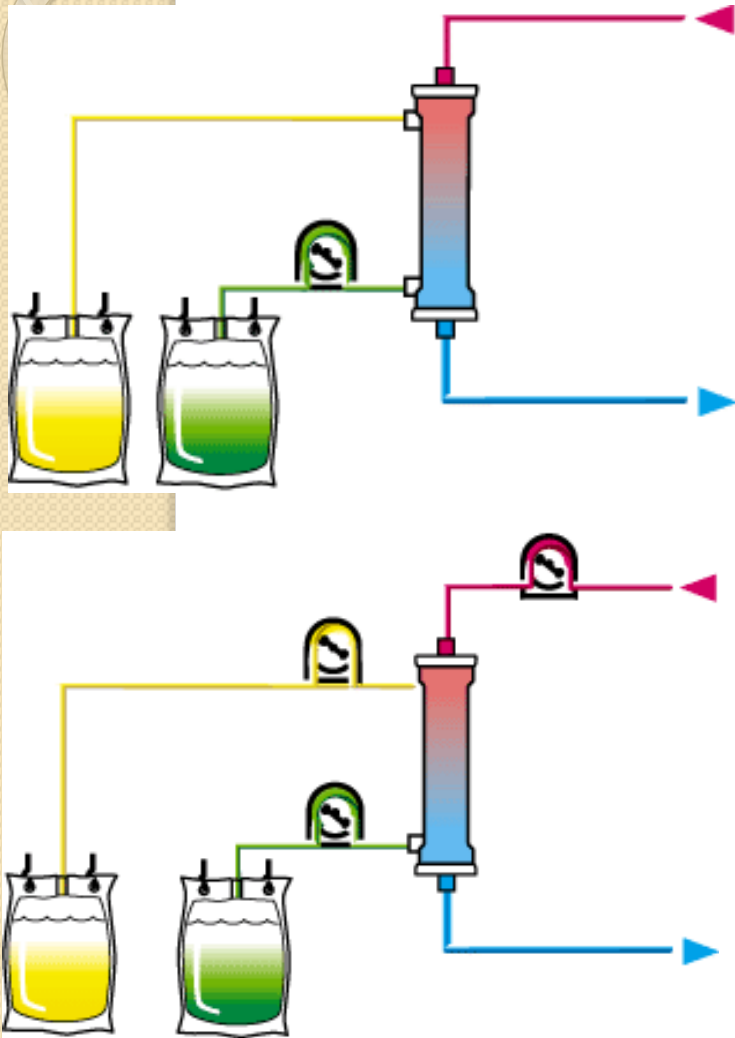
- High flux membranes
  - Up to 24 hrs per day
  - Objective VOLUME control
  - *Not* suitable for solute clearance
- 
- Blood flow 50-200 ml/min
  - UF rate 2-8 ml/min

# CA/VVH



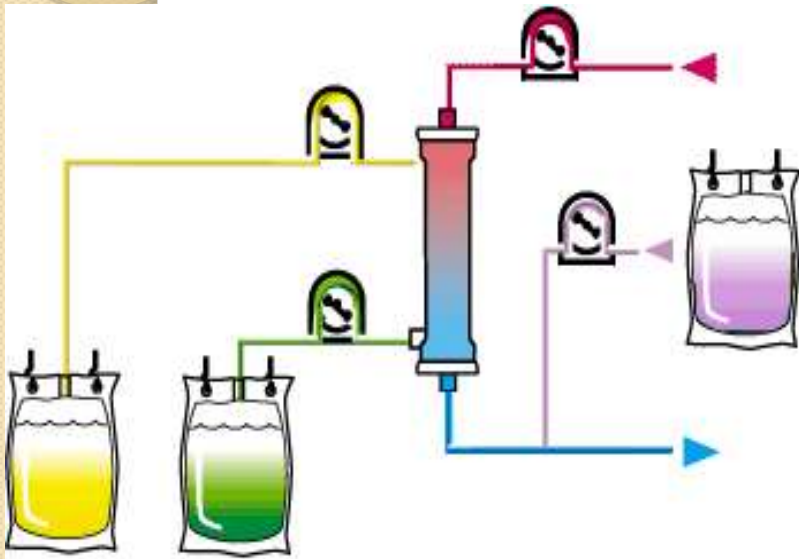
- Extended duration up to weeks
  - High flux membranes
  - Mainly **convective** clearance
  - $UF > \text{volume control amount}$
  - Excess UF **replaced**
  - Replacement pre- or post-filter
- 
- Blood flow 50-200 ml/min
  - UF rate 10-60 ml/min

# CA/VVHD



- Mid/high flux membranes
  - Extended period up to weeks
  - **Diffusive** solute clearance
  - Countercurrent dialysate
  - UF for volume control
- 
- Blood flow 50-200 ml/min
  - UF rate 1-8 ml/min
  - Dialysate flow 15-60 ml/min

# CVVHDF



- High flux membranes
  - Extended period up to weeks
  - **Diffusive & convective** solute clearance
  - Countercurrent dialysate
  - UF exceeds volume control
  - **Replacement** fluid as required
- 
- Blood flow 50-200 ml/min
  - UF rate 10-60 ml/min
  - Dialysate flow 15-30 ml/min
  - Replacement 10-30 ml/min



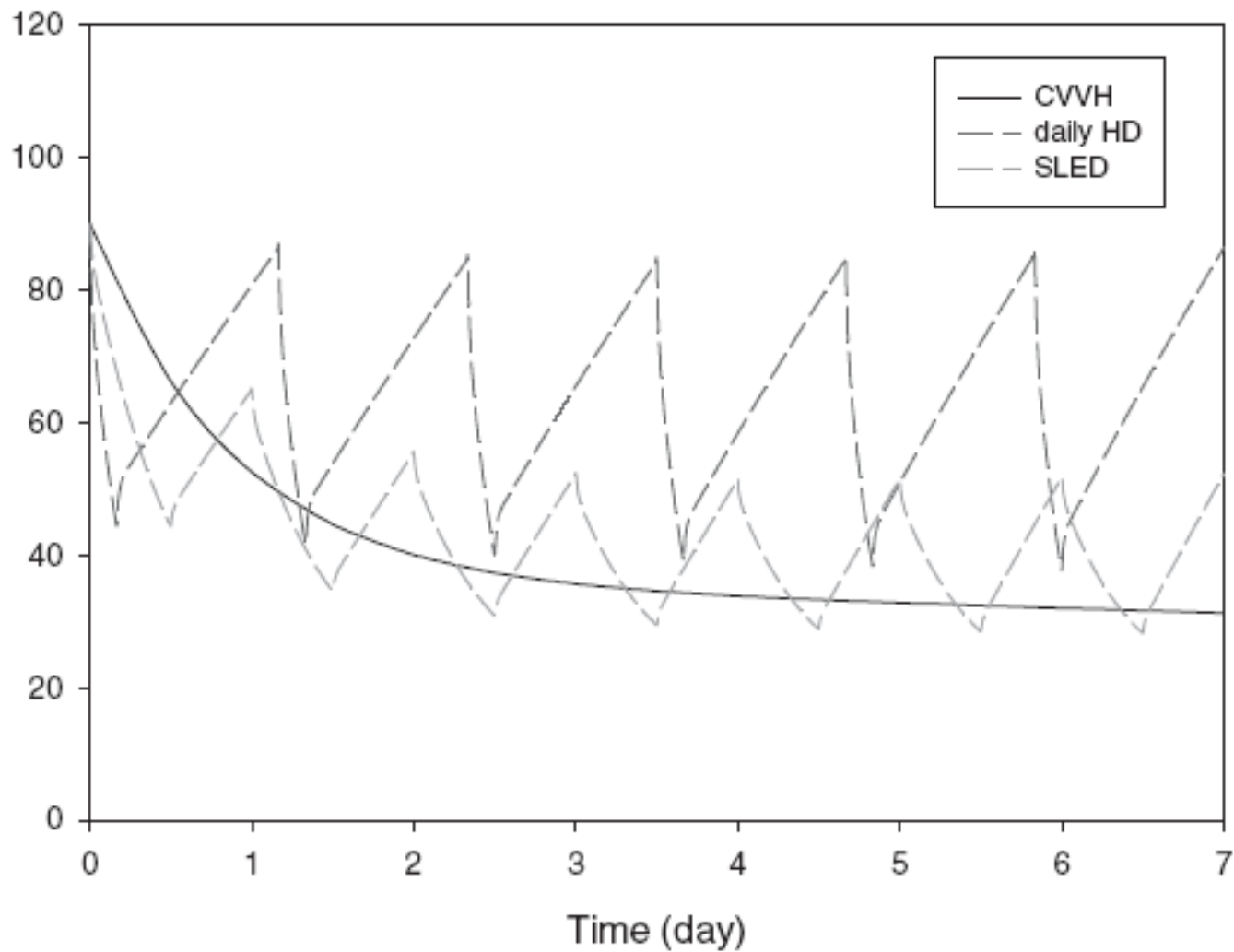
# SLED(D) & SLED(D)-F : Hybrid therapy

- Conventional dialysis equipment
- Online dialysis fluid preparation
- *Excellent* small molecule detoxification
- Cardiovascular stability as good as CRRT
- Reduced anticoagulation requirement
- 11 hrs SLED comparable to 23 hrs CVVH
- Decreased costs compared to CRRT
- Phosphate supplementation required

Fliser, T & Kielstein JT. Nature Clin Practice Neph 2006; 2: 32-39

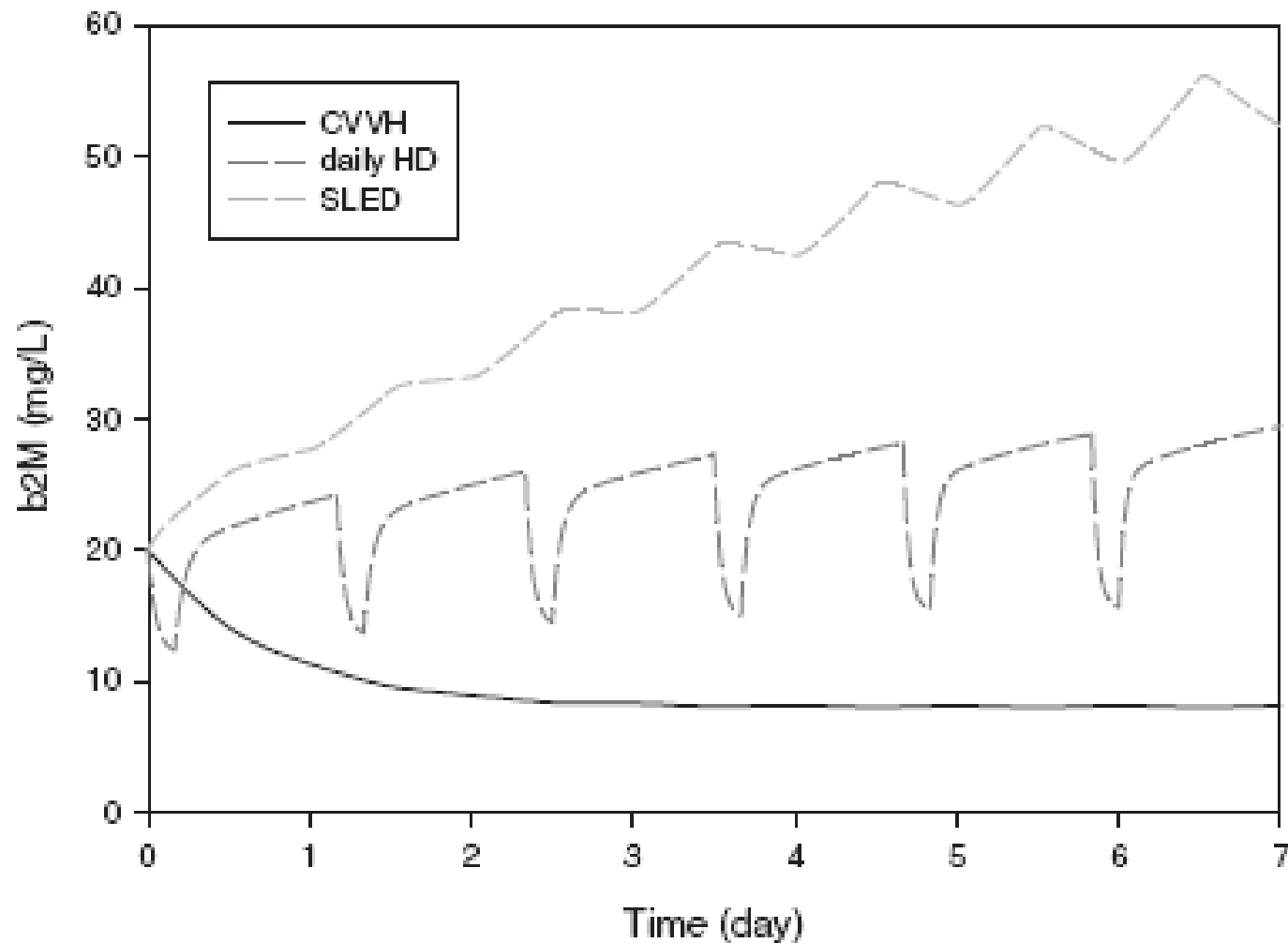
Berbece, AN & Richardson, RMA. Kidney International 2006; 70: 963-968

# Uraemia Control



Liao, Z *et al.* Artificial Organs 2003; 27: 802-807

# Large molecule clearance



Liao, Z *et al.* Artificial Organs 2003; 27: 802-807

## A randomized clinical trial of continuous versus intermittent dialysis for acute renal failure

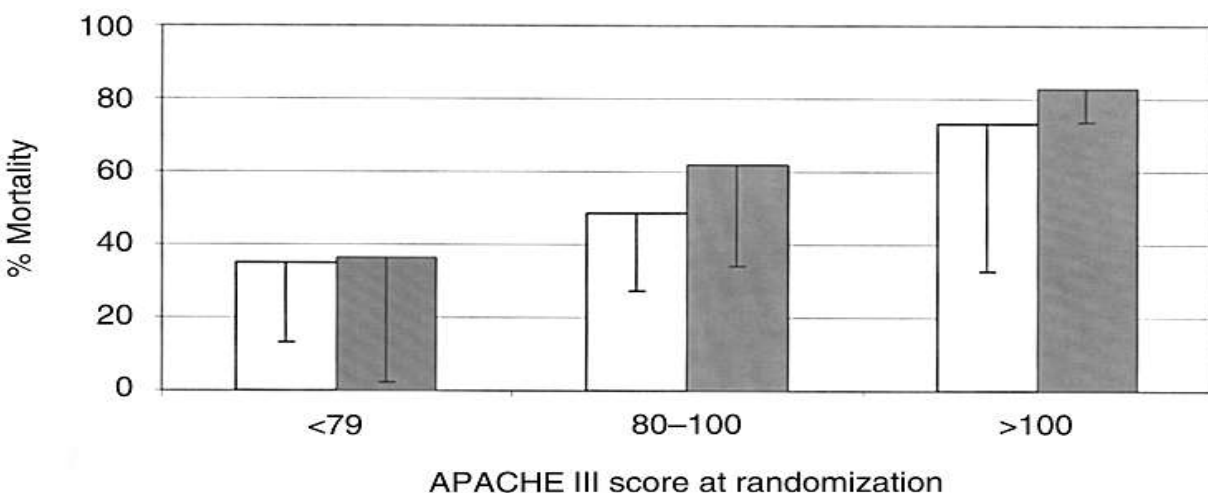


Fig. 2. Effect of severity of illness on mortality in the intermittent hemodialysis (□) and continuous renal replacement therapy (■) groups.

In summary, our study proved that a randomized controlled trial in critically ill patients with ARF is feasible. While overall mortality was lower than reported previously, unadjusted results showed an increase in ICU and in-hospital mortality among patients treated with CRRT, although this difference was best explained by more severe illness in the CRRT group, despite randomization. Complete recovery of renal function was more common in patients assigned to the CRRT arm. This



# Intermittent Hemodialysis Versus Continuous Renal Replacement Therapy for Acute Renal Failure in the Intensive Care Unit: An Observational Outcomes Analysis

Journal of Intensive  
Care Medicine  
Volume 23 Number 3  
May/June 2008 195-203  
© 2008 Sage Publications  
10.1177/0885066608315743  
<http://jicm.sagepub.com>  
hosted at  
<http://online.sagepub.com>

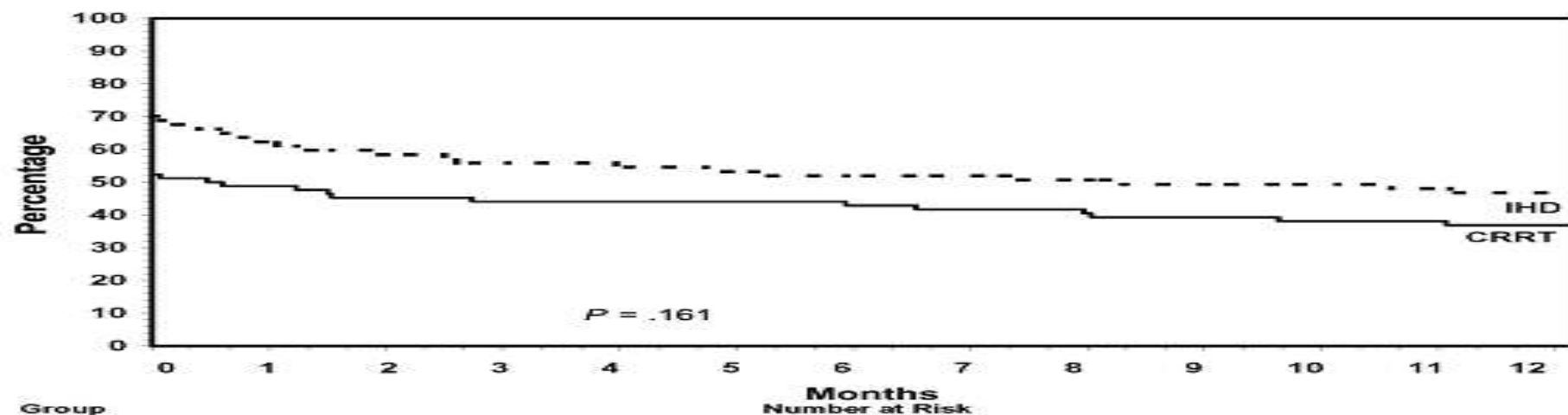


Table 2. Observed Economic Outcomes by Method of Renal Replacement<sup>a</sup>

31  
36

31  
36

Endpoint	CRRT (N = 84), Mean ± SD	IHD (N = 77), Mean ± SD	Difference (95% CI)	P Value
Total costs	\$106 377 ± 122 327	\$54 821 ± 64 091	\$51 556 (\$20 749, \$82 363)	.001
Hospital costs	\$97 116 ± 113 813	\$49 711 ± 58 983	\$47 404 (\$18 803, \$76 005)	.001
Room and board	\$35 995 ± 52 180	\$23 645 ± 28 563	\$12 350 (−\$1087, \$25 787)	.071
Dialysis <sup>b</sup>	\$8052 ± 8691	\$3254 ± 4036	\$4799 (\$2657, \$6940)	<.001
Pharmacy	\$18 486 ± 21 617	\$6768 ± 10 964	\$11 718 (\$6309, \$17 128)	<.001
Laboratory	\$13 087 ± 12 941	\$5879 ± 7658	\$7208 (\$3860, \$10 556)	<.001
Physician costs	\$9262 ± 9462	\$5110 ± 6016	\$4152 (\$1658, \$6645)	.001
Length of stay	17.2 ± 28.24	10.8 ± 13.22	6.48 (−0.48, 13.45)	.068

# Outcome with IRRT vs CRRT

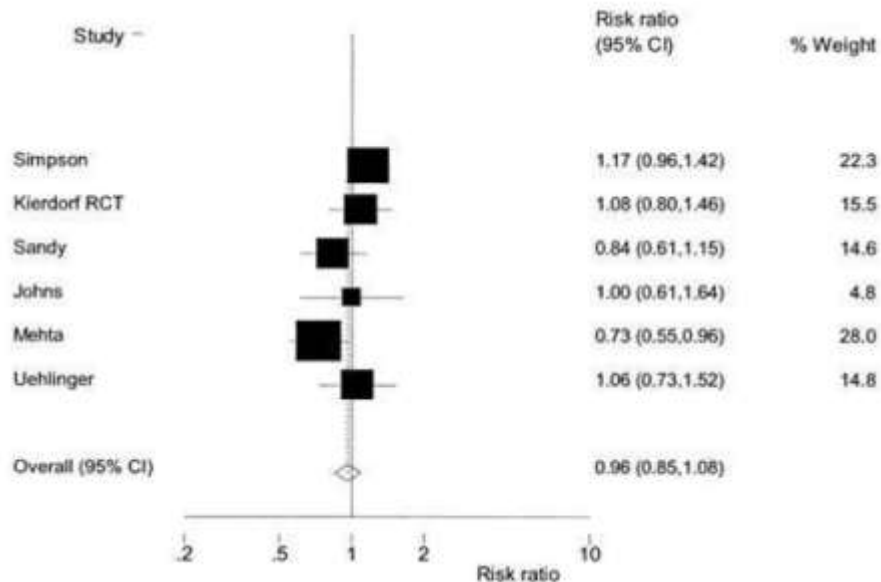


Fig. 2. RR for death for IHD: primary analysis (randomized trials).

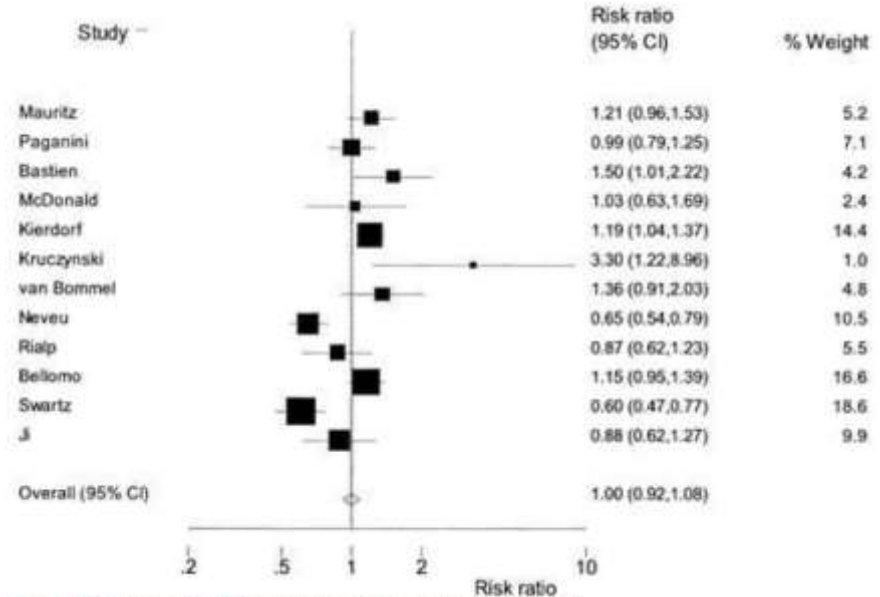
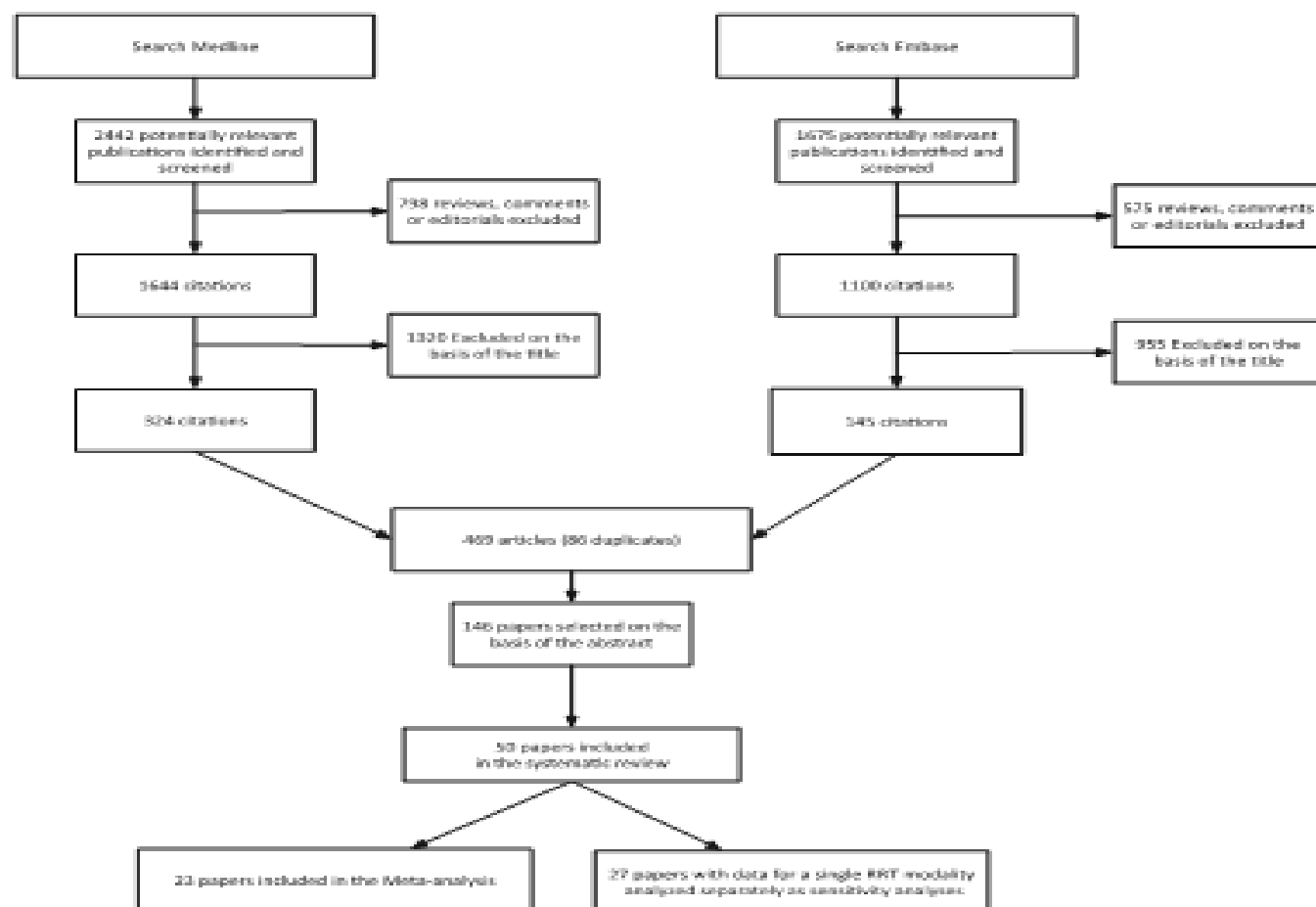


Fig. 3. RR for death for IHD: sensitivity analysis (nonrandomized trials).

- No mortality difference between therapies
- No renal recovery difference between therapies
- Unselected patient populations
- Majority of studies were **unpublished**

Antoine G. Schneider  
Rinaldo Bellomo  
Sean M. Bagshaw  
Neil J. Glassford  
Serigne Lo  
Min Jun  
Alan Cass  
Martin Gallagher

# Choice of renal replacement therapy modality and dialysis dependence after acute kidney injury: a systematic review and meta-analysis



**1** Study selection (CONSORT diagram)



**Table 1** Observational studies: RRT modality-specific patient characteristics

Author [Ref.]	Follow-up	RRT modality	N	Mortality (%)	Males (%)	Age (years)	APACHE II equivalent	CKD (%)	Mechanical ventilation (%)	Vasopressors (%)	% Sur dialysis depen
Andrikos [25]	28 days	CRRT	79	58.2	57.0	66.7	-	8.8	-	-	15.2
		IRRT	12	66.7	83.3	71.2	-	33.3	-	-	25.0
Bagshaw [26]	90 days	CRRT	130	58.5	-	-	-	-	-	-	22.2
		IRRT	110	61.8	-	-	-	-	-	-	35.7
Bell [27]	90 days	CRRT	1911	50.6	65.6	-	-	0.0	-	-	8.3
		IRRT	291	45.7	71.5	-	-	0.0	-	-	16.5
Cartin-Ceba [28]	90 days	CRRT	415	44.8	-	-	-	0.0	-	-	11.3
		IRRT	650	14.6	-	-	-	0.0	-	-	46.1
Chang [29]	90 days	CRRT	53	79.2	79.2	52.0	33.2	-	-	-	9.1
		IRRT	95	53.7	73.7	45.0	21.4	-	-	-	9.1
Lin [34]	90 days	CRRT	242	65.7	-	-	-	-	-	100.0	12.0
		IRRT	100	46.0	-	-	-	-	-	-	20.4
Khanal [41]	90 days	CRRT	32	50.0	59.4	58.3	-	34.0	-	78.0	12.5
		SLED	106	47.2	60.4	57.5	-	45.3	-	77.4	8.9
		IRRT	8	37.5	62.5	70.0	-	75.0	-	62.5	14.3
Swartz [38]	90 days	CRRT	200	68.0	59.0	55.0	26.7	0.0	86.0	80.0	14.3
		IRRT	183	39.9	59.6	60.3	20.0	0.0	27.9	24.0	30.0
Jacka [33]	Hdisch	CRRT	65	62.1	69.2	54.7	25.1	0.0	100.0	62.0	20.0
		IRRT	28	50.0	60.7	62.6	23.5	0.0	100.0	36.0	64.3
Lins [35]	Hdisch	CRRT	26	84.6	-	-	-	0.0	-	-	25.0
		IRRT	74	50.0	-	-	-	0.0	-	-	24.3
Park [37]	Hdisch	CRRT	37	75.7	48.6	61.2	22.4	21.6	100.0	-	14.3
		IRRT	121	31.4	56.4	59.9	19.6	43.0	66.9	-	44.6
Uchino [39]	Hdisch	CRRT	1006	64.2	65.8	66.0	26.1	28.1	84.4	78.8	14.4
		IRRT	212	48.1	60.8	62.0	25.4	37.3	61.8	50.5	33.6

Study or Subgroup	IRRT		CRRT		Weight	Risk Ratio		Risk Ratio	
	Events	Total	Events	Total		M-H, Random, 95% CI	M-H, Random, 95% CI		
1.1.1 Observational									
Andrikos 2009	1	4	5	33	1.5%	1.65 [0.25, 10.81]			
Bagshaw 2006	15	42	12	54	7.0%	1.61 [0.84, 3.06]			
Bell 2007	26	158	78	944	9.8%	1.99 [1.32, 3.00]			
CartinCeba 2009	256	555	26	229	10.3%	4.06 [2.80, 5.90]			
Chang 2004	4	44	1	11	1.3%	1.00 [0.12, 8.08]			
Elsevier 2010	37	175	13	98	7.7%	1.59 [0.89, 2.85]			
Garcia-Fernandes 2011	0	16	0	55		Not estimable			
Gonwa 2001	1	6	4	25	1.4%	1.04 [0.14, 7.71]			
Jacka 2005	9	14	3	24	3.5%	5.14 [1.66, 15.89]			
Lin 2009	11	54	10	83	5.7%	1.69 [0.77, 3.71]			
Lins 2006	9	37	1	4	1.6%	0.97 [0.16, 5.83]			
Marshall 2012	5	56	2	16	2.1%	0.71 [0.15, 3.34]			
Park 2005	37	83	1	9	1.5%	4.01 [0.62, 25.86]			
Swartz 2005	24	110	10	64	6.7%	1.40 [0.71, 2.73]			
Uchino 2007	37	110	52	360	10.5%	2.33 [1.62, 3.35]			
Waldrop 2005	7	12	6	14	5.8%	1.36 [0.63, 2.94]			
Subtotal (95% CI)	1476		2023		76.4%	1.99 [1.53, 2.59]			
Total events	479		224						
Heterogeneity: Tau <sup>2</sup> = 0.09; Chi <sup>2</sup> = 24.14, df = 14 (P = 0.04); I <sup>2</sup> = 42%									
Test for overall effect: Z = 5.14 (P < 0.00001)									
1.1.2 RCT									
Abe 2010	2	25	3	19	1.8%	0.51 [0.09, 2.74]			
Augustine 2004	8	12	8	13	7.6%	1.08 [0.60, 1.95]			
Kumar 2004	3	12	1	8	1.3%	2.00 [0.25, 15.99]			
Lins 2009	15	60	11	65	6.5%	1.48 [0.74, 2.96]			
Mehta 2001	3	43	4	29	2.4%	0.51 [0.12, 2.09]			
Uehlinger 2005	1	27	1	37	0.8%	1.37 [0.09, 20.95]			
Vinsonneau 2006	6	61	4	61	3.1%	1.50 [0.45, 5.05]			
Subtotal (95% CI)	240		232		23.6%	1.15 [0.78, 1.68]			
Total events	38		32						
Heterogeneity: Tau <sup>2</sup> = 0.00; Chi <sup>2</sup> = 3.20, df = 6 (P = 0.78); I <sup>2</sup> = 0%									
Test for overall effect: Z = 0.71 (P = 0.48)									

## Conclusions

Currently available randomized controlled trials do not allow a definitive conclusion on whether choice of initial RRT modality is associated with greater renal recovery rates. Analysis of observational trials suggests that initial support with IRRT might be associated with a higher rate of RRT dependence amongst survivors who received RRT for AKI. As these studies might be associated with allocation bias and given the human and public health implications of these findings, large studies focusing on renal recovery after AKI according to choice of RRT are needed to fully understand the effects of initial modality choice on subsequent dialysis dependence.



RESEARCH ARTICLE

Open Access



# Outcomes of sustained low efficiency dialysis versus continuous renal replacement therapy in critically ill adults with acute kidney injury: a cohort study

## Key messages

- Treatment with SLED was associated with comparable 30-day mortality and short-term RRT dependence to CRRT.
- Indicators of clinical status, including change in SOFA score within 48-h and fluid removal achieved within seven days, were similar for SLED- and CRRT-treated patients
- SLED can be readily performed for most patients without systemic or regional anticoagulation.

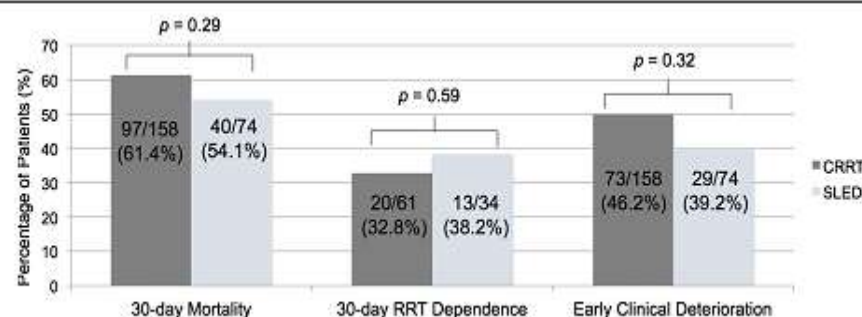
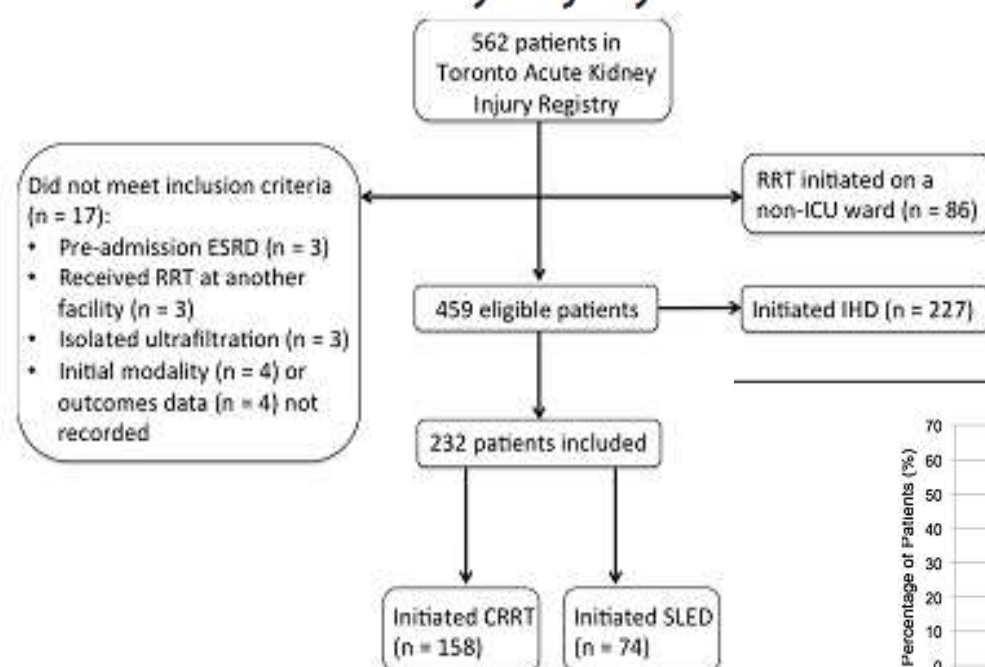


Fig. 2 30-day Mortality, RRT Dependence and Early Clinical Deterioration by RRT Modality

## Original Investigation

# Extended Daily Dialysis Versus Continuous Renal Replacement Therapy for Acute Kidney Injury: A Meta-analysis

Ling Zhang, MD,<sup>1,2</sup> Jiqiao Yang, MD,<sup>3</sup> Glenn M. Eastwood, MD,<sup>2</sup> Guijun Zhu, MD,<sup>2,4</sup>  
Aiko Tanaka, MD,<sup>2</sup> and Rinaldo Bellomo, MD, PhD<sup>2</sup>

## Types of Studies

We included all RCTs and observational studies concerning EDD versus CRRT for patients with AKI from 2000 to 2014. We excluded reviews, commentaries, and editorials.

**607** Potentially relevant studies identified by research

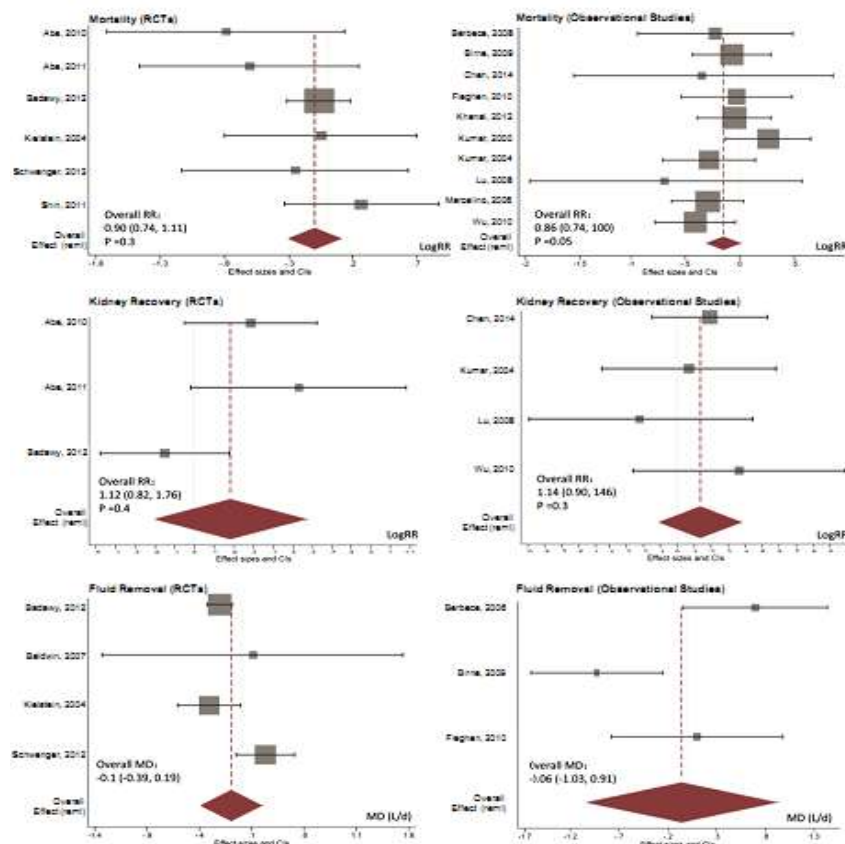
MEDLINE (n = 206)  
EMBASE (n = 267)  
Cochrane (n = 89)  
Others (n = 45)

**17** studies included in the meta-analysis  
7 RCTs  
10 Observational

In conclusion, available RCTs do not show a difference in mortality between EDD and CRRT. However, observational studies suggest that EDD may be associated with a greater survival rate. Because these studies might be associated with allocation or selection bias, further high-quality RCTs focused on mortality according to different RRT modalities are necessary to fully understand the effects of EDD for patients with AKI.

## AJKD

Zhang et al



# Peritoneal Dialysis as a Mode of Treatment for Acute Kidney Injury in Sub-Saharan Africa

Country	Costs for day 1 includes treatment and catheter	Costs for individual treatments	Total costs for 6 treatments
Uganda	600	100	1,100
Ethiopia	260	100	760
Nigeria	260	125	885
Ghana	300	100	800
Kenya	500	90	900
Tanzania	500	150	1,250

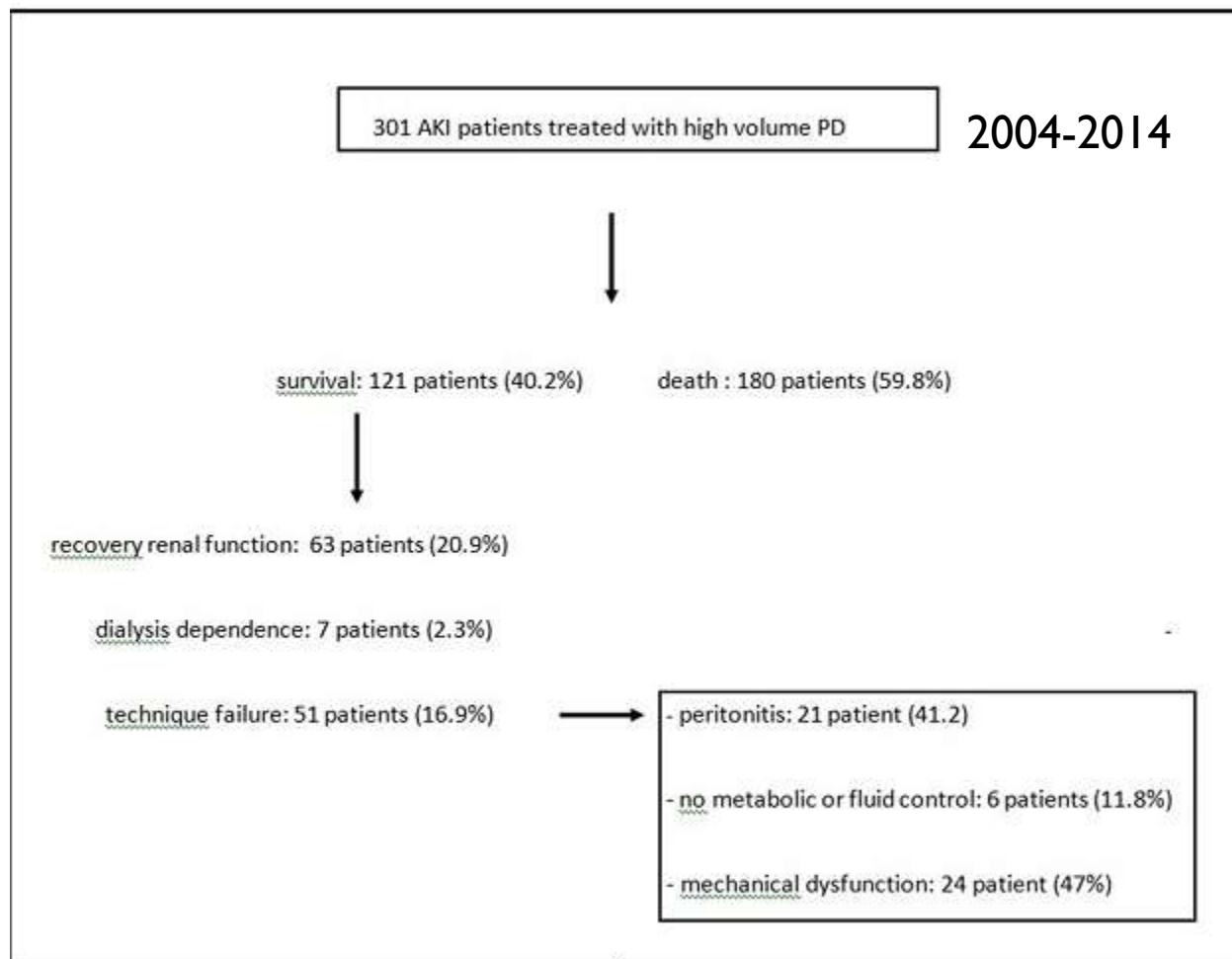
## Conclusion

Measures to prevent kidney failure are important and need to be addressed. However, we cannot ignore those patients that are currently inflicted. Using PD to treat AKI as outlined can bring life-saving treatment to a large percentage of the affected population in many developing countries. It is more affordable than HD, can be started in the low-resource settings and is more desirable as a treatment option for children. While we will continue to



# Peritoneal Dialysis in Acute Kidney Injury: Trends in the Outcome across Time Periods

Daniela Ponce\*, Marina Berbel Buffarah, Cassiana Goes, André Balbi



# High volume peritoneal dialysis vs daily hemodialysis: A randomized, controlled trial in patients with acute kidney injury

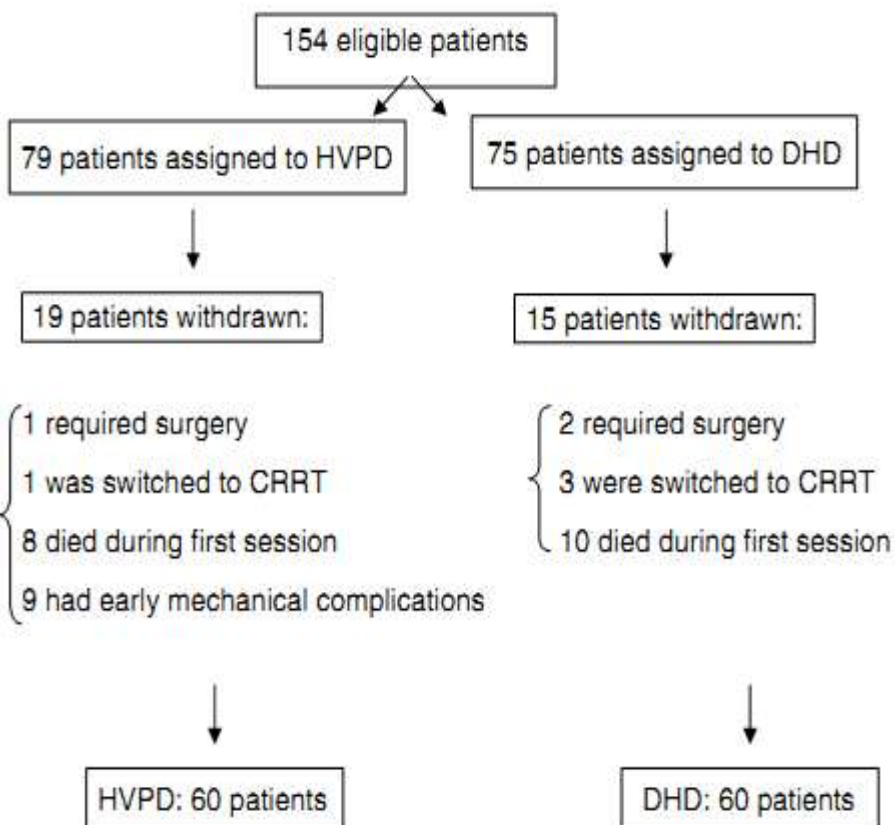


Table 2 | Outcomes according to treatment group

	HVPD (n=60)	DHD (n=60)	P-value
Mortality (%)	58	53	0.48
Recovery of kidney function (%)	83	77	0.84
Duration of treatment (days)	5.5 ± 2.7	7.5 ± 3.1	0.02
Resolution of AKI (days)	7.2 ± 2.6	10.6 ± 4.7	0.04



# APPROACH TO THE METABOLIC IMPLICATIONS OF PERITONEAL DIALYSIS IN ACUTE KIDNEY INJURY

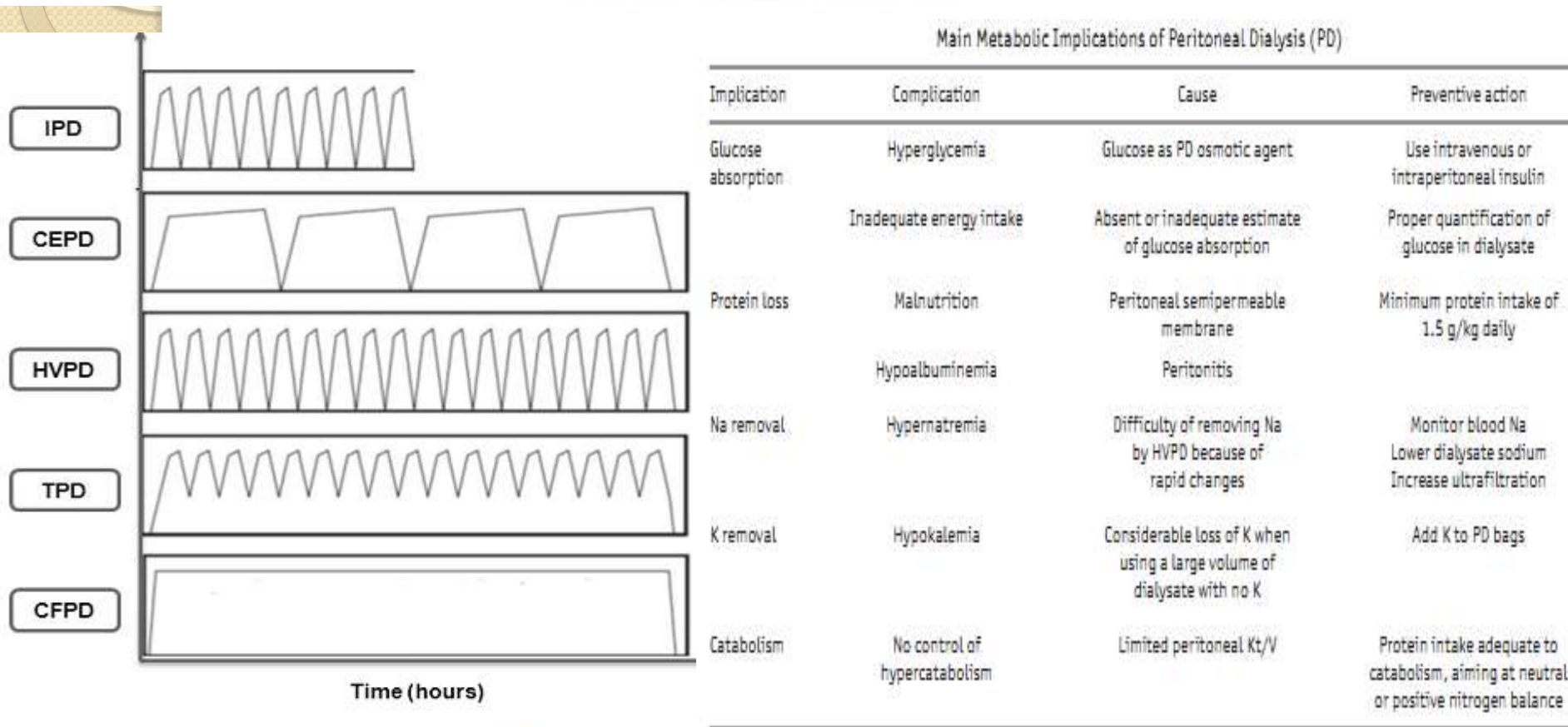


Figure 1 — Peritoneal dialysis modalities used in acute kidney injury. Adapted from Ponce *et al.* (28). IPD = intermittent peritoneal dialysis (PD); CEPD = chronic equilibrated PD; HVPD = high-volume PD; TPD = tidal PD; CFPD = continuous-flow PD.

## Dialysis Interventions for Treatment of AKI

- **5.6.2:** We suggest using **CRRT**, rather than **standard intermittent RRT**, for **hemodynamically unstable patients.** **(2B)**

- **5.6.3:** We suggest using CRRT, rather than intermittent RRT, for AKI **patients with acute brain injury or other causes of increased intracranial pressure or generalized brain edema.** **(2B)**



Using what?

# Vascular access



- **5.4.1:** We suggest initiating RRT in patients with AKI via an **uncuffed nontunneled dialysis catheter**, rather than a tunneled catheter. **(2D)**
- **5.4.2:** When choosing **a vein for insertion of a dialysis catheter** in patients with AKI, consider these preferences **(Not Graded)**:
  - **First choice:** right jugular vein;
  - **Second choice:** femoral vein;
  - **Third choice:** left jugular vein;
  - **Last choice:** subclavian vein with preference for the dominant side.

## Solutions for CRRT

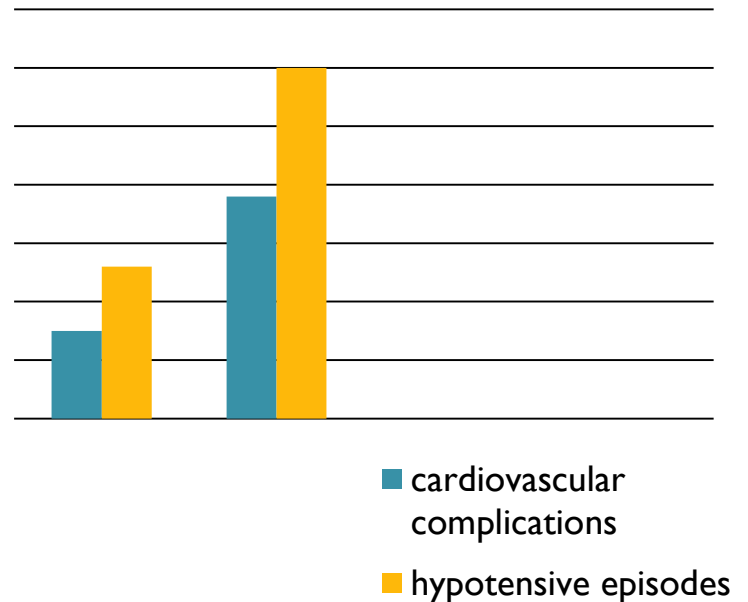
### *Bicarbonate versus lactatebased fluid replacement in CVVH*

Prospective, randomized study

- **Results :**

- ***Serum lactate concentration was significantly higher and the bicarbonate was lower in patients treated with lactatebased solutions***
- ***Increased incidence of CVS events in pts ttt with lactate solution***
  - ***Hypotension***
  - ***Increased dose of inotropic support***

barenborck and colleague



**Barenbrock M et al; Kidney Int (2000)**



## Dialysis Interventions for Treatment of AKI

**5.7.3**: We suggest using **bicarbonate**, rather than lactate, as a buffer in dialysate and replacement fluid for RRT in patients with AKI and liver failure and/or lactic acidemia. (**2B**)

## ***The Membrane***

- ***High Flux membrane , synthetic , biocompatible , acting by providing both methods of detoxications:***
  - a) ***Diffusion*** : for low molecular weight toxins.
  - b) ***Convection*** : for large molecules.

**5.5.1** : We suggest to use dialyzers with a biocompatible membrane for IHD and CRRT in patients with AKI. (2C)

# Anticoagulation

Modality	Advantages	Disadvantages
<b>Heparin</b>	Good anticoagulation	Thrombocytopenia bleeding
<b>LMWH</b>	Less thrombocytopenia	bleeding
<b>Citrate</b>	Lowest risk of bleeding	Metabolic alkalosis, hypocalcemia special dialysate
<b>Regional Heparin</b>	Reduced bleeding	Complex management
<b>Saline flushes</b>	No bleeding risk	Poor efficacy
<b>Prostacycline</b>	Reduced bleeding risk	Hypotension poor efficacy

**5.3.2.1**: For anticoagulation in **intermittent** RRT, we recommend using either **unfractionated or low-molecular weight heparin**, rather than other anticoagulants. (**1C**)

**5.3.2.2**: For anticoagulation in **CRRT**, we suggest using **regional citrate** anticoagulation rather than heparin in patients who do not have contraindications for citrate. (**2B**)



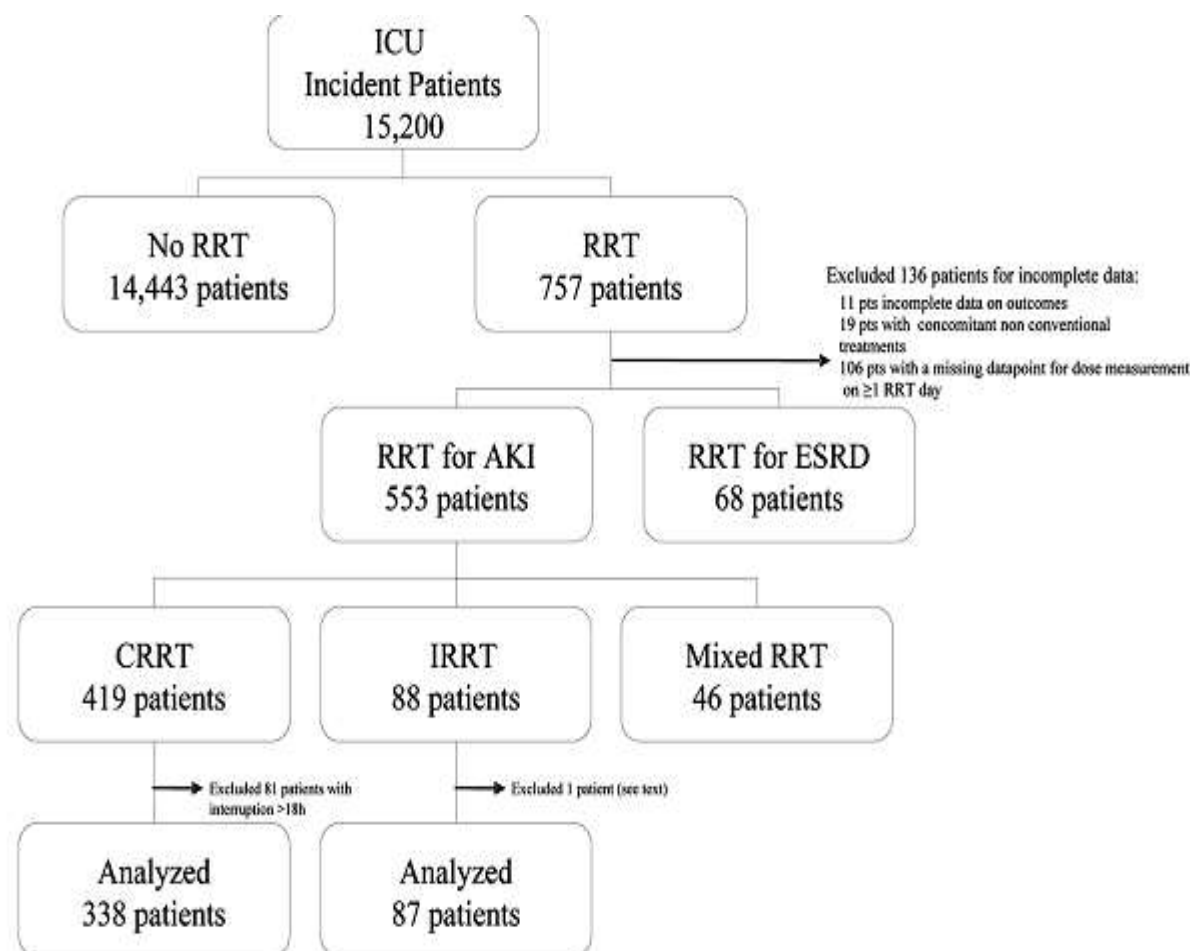
How much therapy?



# Delivered dose of renal replacement therapy and mortality in critically ill patients with acute kidney injury

Sergio Vesconi<sup>1\*</sup>, Dinna N Cruz<sup>2\*</sup>, Roberto Fumagalli<sup>3</sup>, Detlef Kindgen-Milles<sup>4</sup>, Gianpaola Monti<sup>1</sup>, Anibal Marinho<sup>5</sup>, Filippo Mariano<sup>6</sup>, Marco Formica<sup>7</sup>, Mariano Marchesi<sup>8</sup>, Robert René<sup>9</sup>, Sergio Livigni<sup>10</sup>, Claudio Ronco<sup>2</sup> for the DOse REsponse Multicentre International collaborative Initiative (DO-RE-MI Study Group)

*Critical Care* 2009, **13**:R57



## ICU length of stay and ventilation days by RRT dose

	Total	CRRT		
		< 35 ml/kg/hour	≥ 35 ml/kg/hour	P
Length of ICU stay (days)	13 (6.5 to 26)	15 (9 to 28)	8 (4 to 18)	< 0.001
Patients who survived	19 (11 to 32)	19.5 (12 to 33.5)	15 (8 to 26)	0.063
Patients who died	10 (4 to 19)	12 (6 to 20)	4.5 (3 to 9.5)	< 0.001
Duration of MV (days)	10 (4 to 19)	12 (5 to 21)	5 (2.5 to 13)	< 0.001
Patients who survived	14 (4.5 to 22)	14 (5 to 24)	7 (4 to 17)	0.031
Patients who died	8.5 (3 to 17)	10 (5 to 18)	4 (2 to 9.5)	< 0.001

## IRRT

	Total	Frequency < 6 sessions/week	Frequency ≥ 6 sessions/week	P
Length of ICU stay (days)	14 (6.5 to 23)	18 (15 to 31)	9.5 (6 to 18)	0.023
Patients who survived	11 (6 to 20)	18 (13 to 35)	8 (5.5 to 14)	0.008
Patients who died	17 (12 to 23)	18 (17 to 23)	15 (12 to 22)	0.597
Duration of MV (days)	8 (1 to 17)	14 (5 to 21)	6 (0 to 14)	0.030
Patients who survived	5 (0 to 13)	12 (3 to 24)	2.5 (0 to 10)	0.026
Patients who died	17 (11 to 21)	18 (17 to 21)	14 (8 to 18)	0.252

## Key messages

- In this observational study, the delivered CRRT dose was markedly lower than 35 ml/kg/hour (median = 27).
- Alternate day IRRT for critically ill patients was uncommon in the participating centres.
- After adjustment for multiple variables, there was no beneficial effect of more-intensive RRT dose on ICU survival.
- Shorter ICU stay and duration of mechanical ventilation were observed in the more-intensive RRT groups.

5.8.4: We recommend delivering an effluent volume of 20–25 ml/kg/h for CRRT in AKI (1A). This will usually require a higher prescription of effluent volume. (*Not Graded*)

Kidney International Supplements (2012) 2, 89–115

**Table 2.** Characteristics of Study Treatments and Subsequent Use of Renal-Replacement Therapy.\*

Characteristic	Higher-Intensity CRRT	Lower-Intensity CRRT
Duration of study treatment — days	6.3±8.7	5.9±7.7
Flow rate of effluent — ml/kg/hr	33.4±12.8	22±17.8
Dose delivered — %	0.84±0.27	0.88±0.34
BUN — mmol/liter/day‡	12.7±8.5	15.9±7.9
Serum creatinine — μmol/liter/day§	170±121	204±115
Dialysate and replacement fluid — ml/hr	2588±1122	1666±1204
Dose of effluent — ml/hr/day	2698±1154	1771±1257
Net ultrafiltration — ml/hr	110±100	106±108
Fluid balance — ml/day	−20±29	−20±26

Intensity of Continuous Renal-Replacement Therapy  
in Critically Ill Patients  
The RENAL Replacement Therapy Study Investigators\*



**5.8.4: We recommend delivering an effluent volume of 20–25 ml/kg/h for CRRT in AKI (1A). This will usually require a higher prescription of effluent volume. (*Not Graded*)**

3 mg/dl (265  $\mu$ mol/l) and plasma urea around 60 mg/dl (10 mmol/l). The mean plasma urea was kept at  $68 \pm 24$  mg/dl ( $11.3 \pm 4$  mmol/l) in the intensified and  $114 \pm 36$  mg/dl ( $19 \pm 6$  mmol/l) in the standard group. Mortality at 28 days was not statistically different between groups (38.7% and 44.4%) and the frequency of survivors recovering kidney function at day 28 was very similar (63% and 60%).

In CKD, the analysis by Gotch and Sargent<sup>779</sup> of the National Cooperative Dialysis Study showed that survival could be increased by increasing Kt/V to 1.0–1.2. Analysis of a large database of 2311 Medicare IHD patients also showed a strong association between the delivered IHD dose and mortality, with a decreased mortality risk of 7% for each 0.1 higher level of delivered Kt/V in CKD patients. However, above a Kt/V of 1.3, no further decrease in mortality was noted.<sup>780</sup> The HEMO study, a large RCT comparing two different dialysis doses in CKD, also could not demonstrate a further reduction of mortality with equilibrated Kt/V of 1.43

prescription will need to be in the range of 25–30 ml/kg/h. The Randomized Evaluation of Normal vs. Augmented Level of RRT study was conducted in 35 centers in Australia and New Zealand.<sup>562</sup> It compared the effects of postdilution CVVHDF at doses of 25 and 40 ml/kg/h on 28- and 90-day mortality rates in 1464 AKI patients. The delivered dose was 88% and 84% of prescribed in the low- and high-dose groups, respectively. As in the ARFTN study, there was no difference in 28- or 90-day mortality between the two groups. Apart from a higher incidence of hypophosphatemia in the high-dose group, the complication rate was similar.<sup>562</sup>

In conclusion, there are now consistent data from two large multicenter trials showing no benefits of increasing CRRT doses in AKI patients above effluent flows of 20–25 ml/kg/h. In clinical practice, in order to achieve a delivered dose of 20–25 ml/kg/h, it is generally necessary to prescribe in the range of 25–30 ml/kg/h, and to minimize interruptions in CRRT.



# Associations between Intensity of RRT, Inflammatory Mediators, and Outcomes

Raghavan Murugan,<sup>\*,†</sup> Xiaoyan Wen,<sup>\*,†</sup> Christopher Keener,<sup>\*,†,‡</sup> Francis Pike,<sup>\*,†,‡</sup> Paul M. Palevsky,<sup>\*,†,§</sup> Mark Unruh,<sup>\*,†</sup> Kevin Finkel,<sup>||</sup> Anitha Vijayan,<sup>\*\*</sup> Michele Elder,<sup>\*,†</sup> Yi-Fan Chen,<sup>\*,†</sup> and John A. Kellum,<sup>\*,†</sup> on behalf of the Biological Markers of Recovery for the Kidney (BioMaRK) Study Investigators

## Abstract

**Background and objectives** Critically ill patients requiring RRT have higher circulating plasma concentrations of inflammatory and apoptosis markers that are associated with subsequent RRT dependence and death. Whether intensive dosing of RRT is associated with changes in specific mediators is unknown.

**Design, setting, participants, & measurements** A multicenter, prospective, cohort study of 817 critically ill patients receiving RRT ancillary to the Veterans Affairs/National Institutes of Health Acute Renal Failure Trial Network study was conducted between November 2003 and July 2007. Plasma inflammatory (IL-6, IL-8, IL-10, IL-18, and macrophage migration inhibitory factor) and apoptosis (TNF receptor-I [TNFR-I], TNFR-II, and death receptor-5) biomarkers on days 1 and 8 were examined after initiation of intensive RRT. Whether intensive RRT, given day 1 biomarkers, is associated with RRT independence and lower mortality at day 60 was also examined.

**Results** Overall, no differences were found in day 8 biomarker concentrations between intensive and less-intensive RRT groups. When adjusted for day 1 biomarkers and clinical variables, intensive RRT was not associated with renal recovery (adjusted odds ratio [OR], 0.80; 95% confidence interval, 0.56 to 1.14) or mortality (adjusted OR, 1.15; 95% confidence interval, 0.81 to 1.64). Use of intensive RRT, however, was associated with lower day 8 concentrations when day 1 plasma IL-6, macrophage migration inhibitory factor, and TNFR-I concentrations were high (interaction *P* value for all markers, <0.01). In contrast, day 8 marker concentrations were higher when day 1 levels were low (*P*<0.01). Elevated biomarker concentrations on day 8 among 476 participants were associated with lower renal recovery (adjusted OR range, 0.19–0.87) and higher mortality (adjusted OR range, 1.26–3.18).

**Conclusions** Among critically ill patients receiving RRT, intensive dosing of RRT has variable association with biomarker concentration and no association with renal recovery and mortality. However, elevated concentrations of inflammatory and apoptosis markers on day 8 of RRT were associated with RRT dependence and death.



5.8.1: The dose of RRT to be delivered should be prescribed before starting each session of RRT. (*Not Graded*) We recommend frequent assessment of the actual delivered dose in order to adjust the prescription. (*1B*)

5.8.2: Provide RRT to achieve the goals of electrolyte, acid-base, solute, and fluid balance that will meet the patient's needs. (*Not Graded*)

5.8.3: We recommend delivering a Kt/V of 3.9 per week when using intermittent or extended RRT in AKI. (*1A*)



# When To Stop/Switch?

# Recovery

## Discontinuation of continuous renal replacement therapy: A *post hoc* analysis of a prospective multicenter observational study\*

Shigehiko Uchino, MD; Rinaldo Bellomo, MD; Hiroshi Morimatsu, MD; Stanislao Morgera, MD; Miet Schetz, MD; Ian Tan, MD; Catherine Bouman, MD; Ettiene Macedo, MD; Noel Gibney, MD; Ashita Tolwani, MD; Heleen Oudemans-van Straaten, MD; Claudio Ronco, MD; John A. Kellum, MD

**Objectives:** To describe current practice for the discontinuation of continuous renal replacement therapy in a multinational setting and to identify variables associated with successful discontinuation. The approach to discontinue continuous renal replacement therapy may affect patient outcomes. However, there is lack of information on how and under what conditions continuous renal replacement therapy is discontinued.

**Design:** *Post hoc* analysis of a prospective observational study.

**Setting:** Fifty-four intensive care units in 23 countries.

**Patients:** Five hundred twenty-nine patients (52.6%) who survived initial therapy among 1006 patients treated with continuous renal replacement therapy.

**Interventions:** None.

**Measurements and Main Results:** Three hundred thirteen patients were removed successfully from continuous renal replacement therapy and did not require any renal replacement therapy for at least 7 days and were classified as the "success" group and the rest (216 patients) were classified as the "repeat-RRT" (renal replacement therapy) group. Patients in the "success" group had lower hospital mortality (28.5% vs. 42.7%,  $p < .0001$ ) compared with patients in the "repeat-RRT" group. They also had lower creatinine and urea concentrations and a higher urine output at

the time of stopping continuous renal replacement therapy. Multivariate logistic regression analysis for successful discontinuation of continuous renal replacement therapy identified urine output (during the 24 hrs before stopping continuous renal replacement therapy: odds ratio, 1.078 per 100 mL/day increase) and creatinine (odds ratio, 0.996 per  $\mu\text{mol/L}$  increase) as significant predictors of successful cessation. The area under the receiver operating characteristic curve to predict successful discontinuation of continuous renal replacement therapy was 0.808 for urine output and 0.635 for creatinine. The predictive ability of urine output was negatively affected by the use of diuretics (area under the receiver operating characteristic curve, 0.671 with diuretics and 0.845 without diuretics).

**Conclusions:** We report on the current practice of discontinuing continuous renal replacement therapy in a multinational setting. Urine output at the time of initial cessation of continuous renal replacement therapy was the most important predictor of successful discontinuation, especially if occurring without the administration of diuretics. (Crit Care Med 2009; 37:2576–2582)

**KEY WORDS:** acute renal failure; critical illness; continuous renal replacement therapy; epidemiology; hemofiltration; intensive care



## Discontinuation of continuous renal replacement therapy: A *post hoc* analysis of a prospective multicenter observational study\*

Table 1. Demographics of study patients and variables at starting continuous renal replacement therapy

	All Patients	Success	Repeat-RRT	<i>p</i>
Number of patients	1006	313	216	
Mechanical ventilation	84.1	77.1	80.5	.39
Vasopressors/inotropes	78.8	76.5	63.3%	.0012
Creatinine, $\mu\text{mol/L}$	292 (192–427)	300 (190–428)	366 (265–508)	<.0001
Urea (mmol/L)	23 (15–34)	22 (15–32)	27 (18–38)	.0026
Urine output, mL/6 hrs	100 (23–280)	160 (50–390)	100 (29–253)	.0009
Furosemide, mg/6 hrs	60 (0–200)	60 (0–240)	40 (0–180)	.018
Mode of CRRT, %				
CAVHD	0.1	0	0	—
CVVH	52.8	61.3	48.6	.0043
CVVHD	13.1	7.7	13.4	.039
CVVHDF	34.0	31.0	38.0	.11
Intensity, L/hr	2.0 (1.3–2.1)	2.0 (1.4–2.3)	2.0 (1.4–2.1)	.17

## Discontinuation of continuous renal replacement therapy: A *post hoc* analysis of a prospective multicenter observational study\*

Table 2. Variables at discontinuation of continuous renal replacement therapy

Variables	Success	Repeat-RRT	<i>p</i>
Number of patients	313	216	
Urine output, mL/day	1500 (627–2500)	180 (22–767)	<.0001
Diuretics use	44.9%	24.9%	<.0001
Furosemide, mg/day	0 (0–240)	0 (0–0)	.0001
Other diuretics	4.3%	2.4%	.33
First CRRT period, days	5 (3–9)	8 (4–15)	<.0001
Reasons to stop CRRT, %			
Urine output increased	63.2	19.9	<.0001
Metabolic state improved	49.2	39.8	.039
Fluid overload improved	36.2	31.3	.26
Urea/creatinine decreased	59.0	47.4	.012
Hemodynamically stable	42.7	51.7	.049



# When to Stop?

5.2.1: Discontinue RRT when it is no longer required, either because intrinsic kidney function has recovered to the point that it is adequate to meet patient needs, or because RRT is no longer consistent with the goals of care. (*Not Graded*)

Kidney International Supplements (2012) 2, 89–115

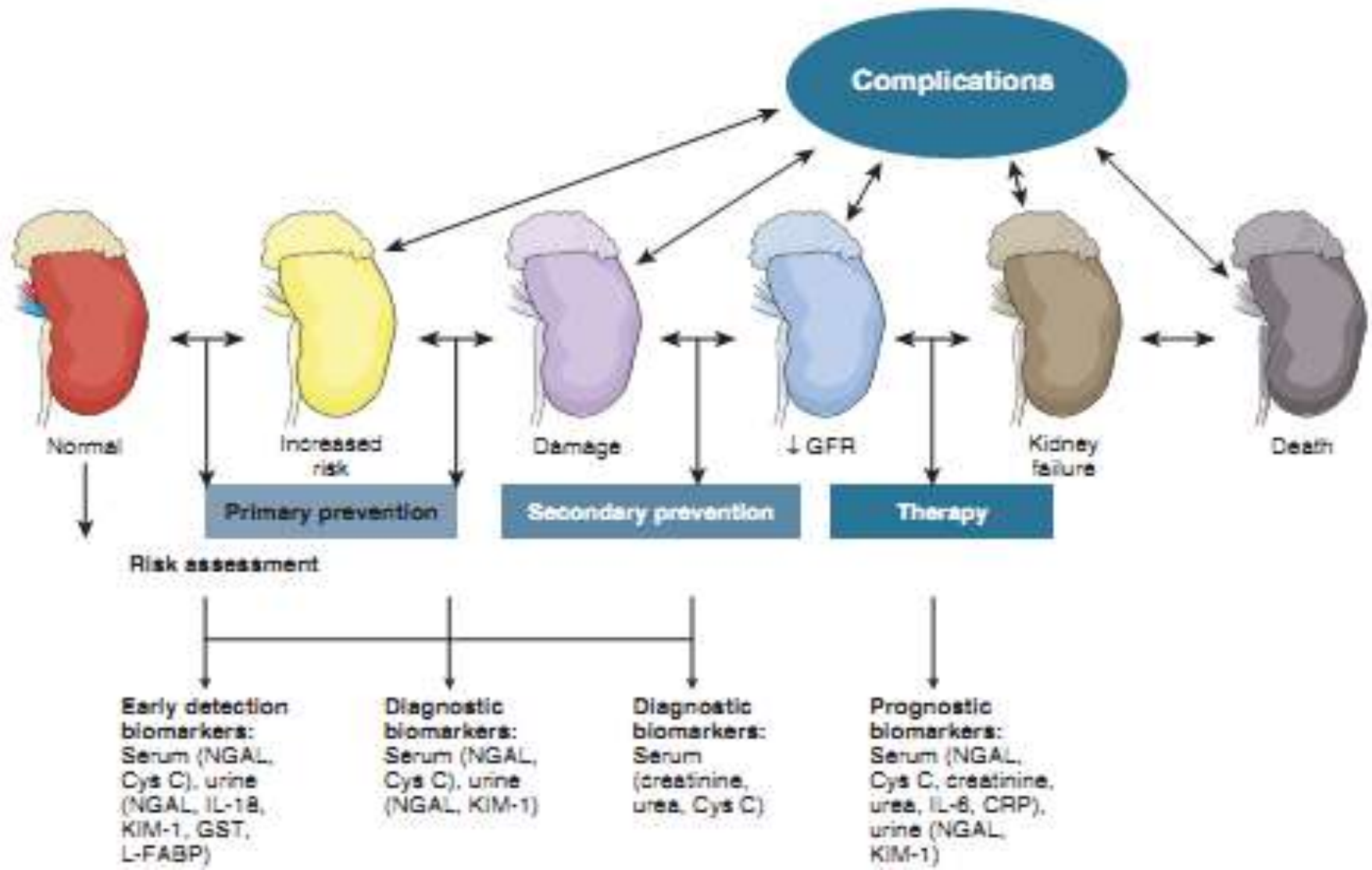
It is also important to acknowledge that there may be patients with a futile prognosis in whom RRT would not be appropriate and where withholding RRT constitutes *good end-of-life care*

Lassnigg A, Schmidlin D, Mouhieddine M et al. J Am Soc Nephrol 2004; 15:1597–1605



**How to improve outcome?**

# Early Detection



# Contd.,

## Renal Angina



### Renal Angina equivalents

1. Oliguria
2. Small increases in SCr
3. Fluid overload



**In the presence of renal angina equivalents, significant research is essential!**

1. Biomarkers
2. Urinary microscopy
3. Urinalysis

Figure 3. Renal angina

SCr: serum creatinine; AKI: acute kidney injury

# How acute kidney injury is investigated and managed in UK intensive care units—a survey of current practice

UK ICU practice reflects the consensus that continuous therapies are preferable in the critically ill patients. Continuous venovenous haemofiltration (CVVH) is the most frequently used form of RRT (56%) followed by CVVHDF (37%). Only 4.5% of ICUs (eight units) use intermittent haemodialysis (IHD) as the main method of RRT and <1% of units (one responding unit only) use a hybrid therapy such as slow low efficiency dialysis (SLED). If any RRT modality were avail-

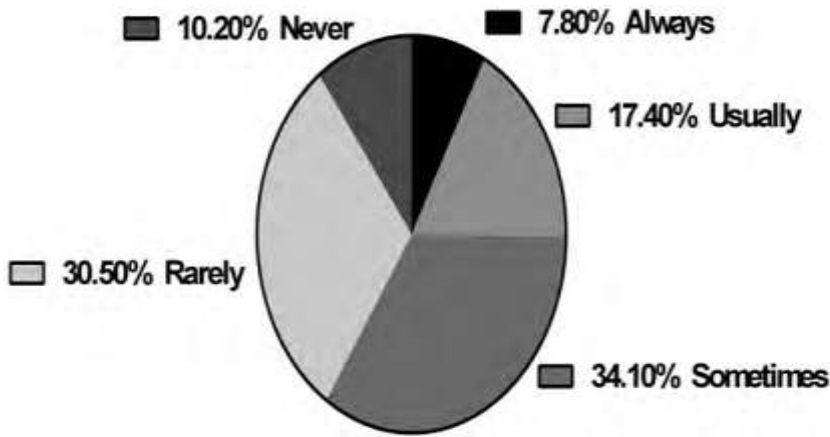
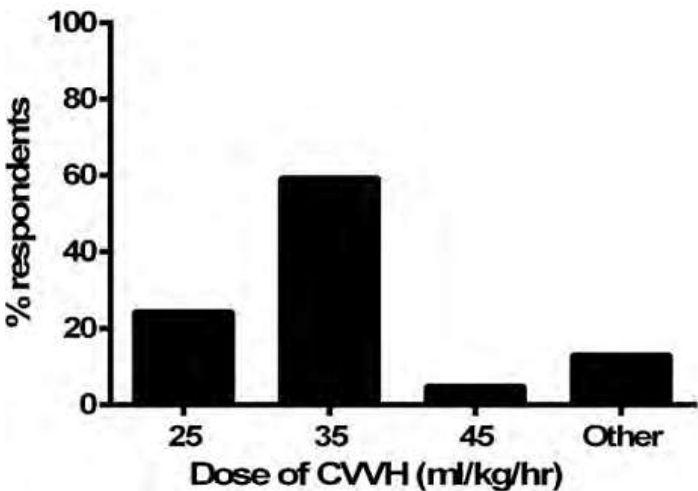


FIGURE 1: Do you involve a nephrologist in the management of patients on your unit with AKI?

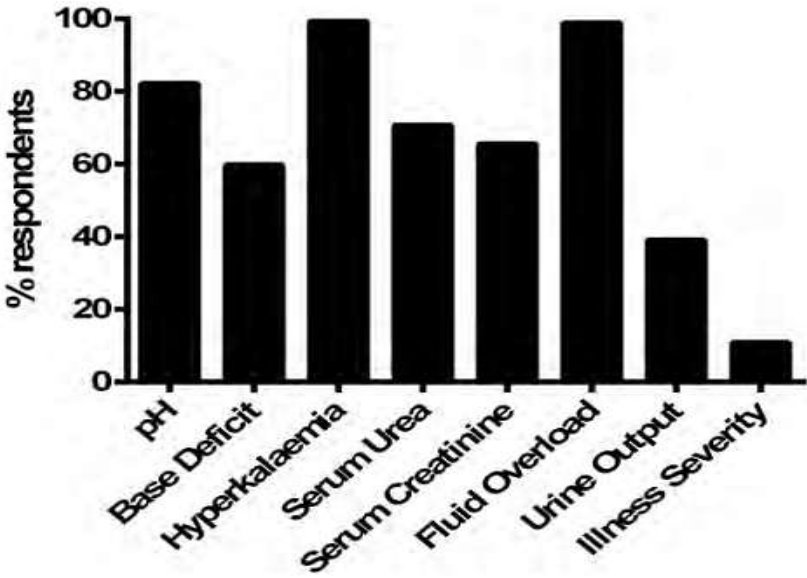


FIGURE 2: Which of these criteria do you use for initiating RRT



# Nephrology in Africa—not yet *uhuru*

Charles R. Swanepoel, Nicola Wearne and Ikechi G. Okpechi

**Table 3** | Workforce and numbers of haemodialysis and PD patients in Africa versus some non-African countries

Country	Year	Population <sup>115</sup>	GNI per capita*	Physicians (per 10,000 population) <sup>116–121</sup>	Nephrologists (pmp) <sup>122–124</sup>	Prevalence of HD (pmp) <sup>11,122,124–127</sup>	Prevalence of CAPD (pmp) <sup>11,122,124–127</sup>	Renal transplants per year <sup>11,122,124–127</sup>
<b>North Africa</b>								
Egypt	2008	81,121,000	6,060	179,900 (24)	500 (6.5)	421.0	45.0	500
Morocco	2008	31,951,000	4,600	1,303 (11)	135 (4.5)	162.0	30.0	13
Tunisia	2008	10,549,000	9,060	2,245 (<1)	70 (7)	650.0	20.0	70
<b>West Africa</b>								
Cote d'Ivoire	2008	19,737,000	1,810	2,746 (1.4)	ND	6.0	ND	ND
Ghana	2009	24,391,000	1,620	2,033 (0.8)	2 (0.1)	6.4	0	0
Mali	2008	15,369,000	1,030	729 (0.5)	ND	1.3	ND	ND
Nigeria	2008	158,423,000	2,240	55,376 (3.5)	70 (0.3)	6.3	0	70
Senegal	2008	12,433,000	1,910	741 (0.6)	2 (0.2)	4.0	2.0	0
<b>East and Central Africa</b>								
Cameroon	2004	19,598,000	2,270	3,124 (1.6)	6 (0.3)	3.6	ND	ND

## Nephrology in Africa—not yet *uhuru*

---

*Charles R. Swanepoel, Nicola Wearne and Ikechi G. Okpechi*

- Special AE
- Lack of resources (finances- equipment-trained medical staff).
- Lack of awareness
- Data quality and accuracy
- Lack of continuous therapies
- Special cultures
- Natural remedies

# Implications of the available data

ARF is *not an innocent bystander* in ICU

We must strive to *avert* acute renal failure

We must ensure *adequate dosing* of RRT

Choice of RRT mode *may* not be critical

Septic ARF *may be a different beast*

# Thank You

---

**HOW DID I END UP HERE?**



by  
Rick Lewis

